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SHIPYARD STANDARDS PROGRAM DEVELOPMENT GUIDE

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The National Shipbuilding Research Program

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SHIP PRODUCTION COMMITTEE
MARINE INDUSTRY STANDARDS PANEL SP-6

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FOREWORD

This report is the product of the National Shipbuilding Research Program (NSRP) project "Shipyard Standards Program Development Guide," MARAD Contract DTMA 91-84-C-41043, conducted under the auspices of the Ship Production Committee's Marine Industry Standards Panel (SP-6) of the Society of Naval Architects and Marine Engineers. The purpose of this study is to develop guidelines for establishing and maintaining an effective standardization program in U. S. shipyards.

Conducted by CDI Marine Company, this study is based on information collected by J. D. Hamilton and K. W. Shafer. The principal author of the report is K. W. Shafer.

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ABSTRACT

This report addresses the need for a Standards Program as a "standard way of doing business." The need for standards is reviewed. Some examples of typical shipyard standards are discussed. The organizational requirements for a successful Standards Program are presented in some detail, including an example Standards Program Charter, and example position descriptions for key Standards Program functions.

Other topics discussed include the organization and functions of the Standards Library. A list of suppliers from which copies of standards can be purchased is provided in an appendix. The need for Cost/Benefit analyses, methods for conducting them, and examples are included. Typical Standards Program Operating Procedures are included to assist shipyard managers in implementing a Standards Program that is tailored to their environment.

The list of references includes many National Shipbuilding Research Program publications and Journal of Ship Production articles that may be helpful in setting up a Standards program. Comments from shipyard reviewers have been incorporated, to the extent the authors concurred.

BACKGROUND

The National Shipbuilding Research Program has produced this guide for use by any shipyard to evaluate the importance of a Standards Program to their shipyard operations. This guide will provide suggested methods for setting up a shipyard Standards Program. It was developed through the Ship Production Committee Panel SP-6, with the cooperation of several U. S. shipyards who were willing to share their experiences in Standards Programs with the authors.

SCOPE

It is generally recognized that standardization at some level will have a favorable effect on the cost of ship construction and repair. Some shipyards have implemented extensive formal Standards Programs, while others have taken a more informal approach. This guide is designed to assist shipyard managers in determining what type of program is best for their environment, and to aid in the implementation of the program.

DEFINITIONS

Production Managers and industrial engineers often think of "standards" as performance standards, such as how many minutes it takes to braze a pipe joint. The Standards Program discussed in this guide is a program designed to establish a "standard way of doing business" in the shipyard, with specific performance standards for production being just one element of the overall Standards Program. The Panel SP-6 charter defines a standard as a "specification, test method, definition, guide, or practice." In this guide, we will be discussing standard procedures for engineering the product, using standard design details, presenting the design information to the trades, buying material, producing the product, and testing the product.

Every shipyard that has been in existence more than a few years has established a "way of doing business," but some have not documented the "standard" procedures in common use. For this study, the definition of a "standard" is a commonly used practice or procedure that has been reduced to writing and has been promulgated formally by shipyard management to all parties affected by the procedure.

WHY HAVE A STANDARDS PROGRAM?

Properly developed and technically valid standards help retain expertise that has been acquired by the shipyard employees through experience. By capturing this experience in documented standards, a shipyard can gain significant productivity benefits without re-inventing the best way to do things every time a key employee leaves the shipyard.

Standards are beneficial to communications. When a Standards Program is functioning properly the shipyard is assured that the same message is being communicated at all levels, and there is less chance for misinterpretation. The use of standards can have significant communication benefits for the purchasing department personnel who deal with suppliers on a daily basis.

The implementation of standards can contribute directly to improvements in quality throughout the shipyard. Indeed, it may be very difficult to achieve quality improvements in many areas without first implementing a Standards Program. For example, how many welds would pass a quality inspection if there were no welding process standards, and no certification standards for welders? Many management systems cannot function effectively without some system of standards for performance planning and measurement. "Group technologist and "manufacturing cells" techniques require some type of standards.

The customer has changed within the last two years, resulting in a greater demand for standardization. The "peace dividend" resulting from the fall of the Berlin wall, the collapse of communism in Eastern Europe, and the disintegration of the former Soviet Union, has led to a significant reduction in United States Navy spending for new ships, and for ship conversions and modernization. The volume of U. S. flag (Jones Act) commercial ship construction work is not sufficient to keep more than a few U. S. shipyards operating at best. Consequently, many shipyards in the United States must now compete for foreign flag commercial shipbuilding business in order to survive. To be truly competitive in a global shipbuilding environment, the United States shipbuilding industry must become substantially more productive. Furthermore, many foreign customers are expected to require their suppliers to comply with the International Standards Organization (1SO) 9000 series of standards for quality programs, commonly referred to as "ISO 9000."

What is 1SO 9000 ? ISO 9000 is a series of five international standards for "Quality Management" and "Quality Assurance." It is not a set of "product" standards, nor is it specific to any one industry. It is a definition of minimal quality system requirements which will help to ensure that manufactured items are produced and delivered in accordance with good quality management practice.

As of late 1991, more than 75 countries have adopted ISO 9000 as their quality system standard. The United States Department of Defense is pursuing steps to replace or modify the venerable MIL-Q-9858A quality system to be consistent with IS0 9000 requirements. The American National Standards Institute and the American Society for Quality Control have adopted the ISO 9000 series word for word in their ANSI/ASQC Q90 series.

An essential element of establishing compliance with ISO 9000 requirements is to have a documented way of doing business, and to operate by it. Thus, the "standard procedures" for developing engineering data and detailed design drawings, for purchasing materials and equipment, for accomplishing production work, for inspecting and accepting the work, and for managing business in a manner that ensures quality, must be reduced to writing in a form that will satisfy third party auditors and lead to certification as an 1SO 9000 certified supplier in order to satisfy the requirements of international customers.

Failure to accomplish ISO 9000 certification may cause international customers to take their business elsewhere, and there are plenty of other places for them to go. As of late 1991, more than 18,000 companies world wide were certified to IS0 9000 standards. It has become, quite simply, a matter of survival to have an effective Standards Program, as part of an overall business management process that is designed to assure the customer that he is getting a product that will meet his requirements. Standard procedures for invoking the ship owner's requirements on the material and equipment suppliers, along with standards for engineering criteria, and standard details for such mundane matters as weld joint designs, methods of joining pipe, standard structural connections, etc., are all part of the overall Standards Program.

Most people knowledgeable of industrial processes believe that an effective Standards Program is essential to cost avoidance and cost control, as well as to quality assurance. A well thought out standard method of accomplishing a task, if practiced consistently, will contribute significantly to being successful the first time, and to being able to improve the process with repetition, which ultimately leads to the lowest possible cost of consistently producing a product that meets the specified quality and performance requirements.

"standards" exist now in every shipyard that has been in operation more than a few years. If this sounds like an overstatement, just ask any employee to explain why a task is performed a certain way. The question is, however, are the present "Standards" a result of conscious decisions made by shipyard management, or have they developed piece-meal as a collection of unrelated decisions made at various times by various personnel with disparate philosophies and vested interests? It is incumbent upon shipyard management to ensure that the standards in daily use are the result of conscious decisions based on performance and value rather than various undocumented practices resulting from personal preferences or requirements that may no longer be valid. Putting standards in writing and formally issuing them as an approved statement of shipyard policy for a project provides an exceptionally strong tool for directing and controlling the activities and productivity of employees throughout the shipyard, which will improve quality, consistency, and competitive position.

In some shipyards, particularly smaller ones, management may find that the employees are using standard ways of doing things that make a lot of sense, although what is being done may never have been thought of as standardization. After all, standardization is really nothing more than documenting good engineering practices, intelligent procurement and material control, and efficient manufacturing and production assembly processes so that they may be appropriately and consistently applied.

How small does a shipyard have to be in order for it not to benefit from a formal Standards Program? Robert Toth addresses this subject in chapter 21 of reference [1]. According to Mr. Toth, the answer is "Rather Small. According to one rule of thumb, any enterprise that employs 45 or more people and spends more than 50 percent of its income on goods and services provided by other companies; and keeps an inventory of raw materials and maintenance spares, should look carefully at the option of setting up a formal Standards Program.

In fact, small companies show a greater return on their standardization investment than their larger counterparts. They benefit more than large companies in the improvement of design coordination, consolidated purchasing, elimination of duplicated parts, and management of inventory. One great advantage to the small shipyard is in procurement discount schedules. The percent of change in unit price between 1 million and 2 million parts is nowhere near as attractive as between 50 and 500 parts."

For larger shipyards, the question is not whether or not to have a Standards Program, but rather what is the most cost effective level? Mr. Toth also addresses this question in reference [1]. "There is a point of diminishing returns in standardization, as in life, at which the expenditure of additional effort isn’t worth the additional return. Each company has to ask itself questions about finding the balance between investment and return - and its willingness to take a long view. - - - Whatever level your company expends on standards, a major consideration is the cost of unnecessary variety that shows up in wasted time searching for information, duplication of drawings, errors caused by inadequate specification of materials and processes, inordinate number of engineering change orders, and ever-increasing paperwork." If these problems sound familiar then additional standardization effort may be in order. An effective Standards Program can be a powerful tool to positively affect the daily operations and profitability of the shipyard.

TYPES OF SHIPYARD STANDARDS

Tyes of shipyard standards can include specifications for parts, sub-assemblies and assemblies; procedures for design, fabrication, installation, testing and inspection; documentation of work instruction methods, work processes, and training materials; and administrative forms, formats, planning charts, presentation aids, etc. The principle types of shipyard standards will be discussed in the following paragraphs.

ENGINEERING STANDARDS

Engineering standards are a definition of the format and content of engineering products to be delivered to the purchasing department, production department, quality assurance activity, and to the ship owner upon delivery of the vessel. Engineering standards address the type of Product to be provided by the engineering function, whereas design standards define specific standard design details to be incorporated in the engineering products.

The type of engineering products required by the production, purchasing, and quality assurance departments are determined by the shipyard’s construction methods, by the overall shipyard organization, and by the requirements of a specific project or shipbuilding program. For example, drawings may be zone oriented, system oriented, or both, depending upon the shipyard’s construction strategy.

Owner's requirements also have to be considered when defining the standards for engineering products. In some cases, the shipyard may use zone oriented drawings to build the ship, but the ship owner may insist that system oriented drawings be delivered with the ship in order to support the life cycle maintenance requirements, or operating engineer requirements for the crew of the vessel. The content of zone oriented drawings may have to be modified to include information required by the ship owner. If additional information is required, the information and the format for presenting the information should be defined by engineering standards. Reference [8] provides a discussion of the type of information that must be included in zone oriented construction drawings to support the life cycle management process.

Reference [2] provides an excellent overview of the application of "Design for Production" techniques, and states that it is essential that all design for production be accomplished by the ship designers. Some shipyards may find that their production planning department does not have confidence in the production engineering ability of the ship designers. Organizational changes may be required to fully incorporate design for production features into the design products. Reference [3] gives a good overview of the overall shipbuilding process, and references [4], [5], [6], and [7] discuss the way shipyard organizations affect the efficiency and productivity of the shipyard.

The use of models in the design process is another topic which affects the format and content of design products. If models are used, the content of the drawings may be different from drawings developed without the benefit of models. Models can be maintained as a production aid after the drawings are developed, which may reduce the number and complexity of the views presented in the drawings. Reference [9] discusses the modeling process and methods of presenting model information to the construction trades in the format of work instructions.

Engineering standards should define the format and content of purchase technical specifications, which are developed in detail by the engineering function in many shipyards. It is feasible to staff the purchasing department with engineering expertise sufficient to develop the purchase specifications directly from the drawings and lists of materials provided by the engineering function; however, this tends to isolate the engineers and designers from the cost implications of their technical decisions. Close integration of the engineering, purchasing, and manufacturing functions is preferable from the standpoint of minimizing procurement costs while providing material and equipment that fully meets the technical requirements and considers the manufacturing process in order to achieve the lowest installed cost, rather than just the lowest purchasing cost.

One of the most important functions of engineering standards is to define and list the external standards that are applicable to a particular project. Reference [1] categorizes external standards as mandatory, obligatory, preferred, non-preferred, and discretionary.

Mandatory standards are those imposed by law or regulation. In the shipbuilding industry, these would include classification society rules, U. S. Coast Guard regulations, and Safety of Life At Sea (SOLAS) conventions. Failure to properly implement these standards could expose the shipyard to potentially severe legal penalties and product liability law suits, especially if the failure to comply with these requirements caused a catastrophic failure and loss of life.

Obligatory standards are those invoked by the contract and specifications. A typical example would be ASTM marine industry standards that are called out in the contract, in contract drawings, or in the specifications. Standards invoked by the specifications or contract drawings must be followed. Standards called out in contract guidance drawings are not obligatory, but should at least be considered as an owner preferred standard. The ship owner's preferred standards should be followed unless an agreement is reached to use an alternative standard proposed by the shipyard. Reference [10] provides some excellent guidance on the process of defining these types of technical issues during the contract negotiation phase.

Preferential external standards are those external standards the shipyard has chosen to adopt for use. Adoption of an external standard as a preferred standard can be accomplished by a policy statement or by reference in an internal standard. There are literally thousands of external standards that can be adopted without change, or adapted by developing an internal standard that chooses specific variations allowed by the external standard. For example, choosing a limited number of preferred standard drawing sizes and dimensional tolerances from among the wide variety of choices available would be an adaptation of an external standard.

Non-preferred external standards would include those that have been found to be undesirable for any reason. Examples would include infrequently used drawing sizes, uncommon dimensional tolerances, or materials and sizes not readily available. .

Discretionary external standards would include any external standard not listed in one of the above categories. Discretionary standards are those external standards that have not been selected by the shipyard for inclusion in the preferred list, or excluded as a non-preferred standard. Discretionary standards form a pool of reference information that can be used by the engineers and designers for general technical information or specific use in unique applications.

In summary, engineering standards are a reflection of the shipyard organization and of the contracts held by the shipyard. Engineering standards are heavily influenced by the interplay between engineering and other shipyard departments, as well as by the contractual requirements established by the ship owner.

DESIGN STANDARDS

With the engineering standards established to define the format and content of engineering products, attention can be turned to the subject of design standards, i. e., exactly what designs are going to be incorporated into the standard engineering products. Design standards are those items or assemblies which appear several times in a ship design. After these design details are drawn once, they can be specified for the various applications by brief reference to the standard. Design standards are normally used across contracts. Some examples are inclined and vertical ladders, pipe supports, fire hose stations, structural connection details, weld joint designs, pipe joint designs, foundations and mounting methods for miscellaneous small equipments, supports for wire ways and ventilation ducts, standards for fabricating ventilation ducts and pipe pieces, types and sizes of fasteners, preferred pipe sizes, etc..

Standardization of the design and drafting practices can be one of the most rewarding efforts of the entire Standards Program. Initially, all detailed design starts in the design and drafting group. All material purchasing, receipt inspection, inventory, manufacturing and production assembly activities result from the design and the materials shown on the design drawings. Any problems or excess costs resulting from the design will affect the shipyard from the beginning of material purchasing through delivery of the completed ship, and will affect the ship owner throughout the life of the ship. For example, production planners and industrial engineers may spend excessive time and money determining how to make a difficult part or assembly. Substantial sums may be spent for special tooling, and it may be necessary to purchase special machinery. The ready availability of design standards and easily retrievable previous designs contribute significantly to the avoidance of design details that are unnecessarily difficult to fabricate and assemble.

Design standards vary significantly from one shipyard to another, and are frequently driven by the availability of equipment, tooling, and labor skills, as well as the types of vessels being built by the shipyard. The efforts of the Standards Program should be directed primarily toward the establishment of easy to use design retrieval methods to promote the use of design details found to be best for a particular shipyard, rather than copy the standards of some other shipyard with different equipment and labor skills. Most important of all is to provide a method to encourage the designers to use the standards. Given the opportunity, designers will use designs that have worked for them in the past. Unfortunately, not all designers have the same experience base, therefore they develop different solutions to the same problem. Significant improvements can be made by ensuring that the designers understand why standards are to be used, and by ensuring that the design checkers and supervisors enforce the design discipline required by an effective Standards Program.

Design standards should be established with direct input from the production engineering and trades personnel that actually do the work. Reference [11] emphasizes the need for integrating the design, purchasing, and production engineering functions in order to achieve producible designs, and provides excellent examples of what can be achieved when this integration is accomplished.

The production trades know better than any other group which details are easy to fabricate and install, and which details frequently cause trouble during construction. The standard designs preferred by the trades will be determined in some part by the skills and training of the production personnel, as well as by the tools and equipment available to them. It is entirely possible that requirements for additional training or specialized tooling will be identified during the process of developing standard design details. It is also likely that a need for additional training of the design personnel will be identified by the process of establishing design standards. For example, do the piping designers fully understand the limitations of the pipe bending equipment? It has been the experience of the authors that pipe designers are frequently not trained in pipe clamping length requirements for pipe bending machines, which are equipment specific. This can lead to incorrect location of field joints and additional time for the production personnel to accomplish the work. Would it save time and money to establish a standard pipe bend radius of five times pipe diameter for all pipe, rather than three times pipe diameter for non-ferrous pipe and five times pipe diameter for ferrous pipe? Questions such as these should be discussed with the production tradesmen, and standard design details that are easy to fabricate and install should become the "standard way of doing business" for the design group.

Another factor to consider is the specific information needed by the production trades. Is all required information provided? Is all information provided actually required? Dialog between designers and the trades is essential to define standards that answer "yes" to both questions.

In general, the systematic use of design standards can shorten the time between contract award and the start of fabrication, and can reduce the cost of the design effort. Broad use of standard drawings depicting installation methods or fabrication details for standard items can also result in lower production costs. Some shipyards have gone to the extent of developing standard structural assembly drawings that can be put together like building blocks to create the production work packages.

Reference [12] contains extensive information regarding design details that have proven to be suitable for efficient production. This reference was developed in cooperation with a number of participating shipyards and includes some relatively unique design details as well as details that are used widely in the marine industry. Most shipyards, even the largest and most sophisticated, can benefit from reviewing the ideas contained in reference [12].

While design standards can benefit a shipyard relying on manual drafting techniques, the greatest benefit stems from using standards in a computer aided environment. In fact, computer aided design (CAD) and computer aided manufacturing (CAM) initiatives provide additional reasons to establish standard design details. Standard details can be stored in a CAD parts library and used repeatedly without having to draw the detail each time. Tom Lamb makes the point in reference [2] that all standard details shouldbe fully drawn out on the drawings in order to eliminate the need for reference drawings on the waterfront. Including all required information on the drawings and eliminating references will help improve the productivity of the production workers. A CAD parts library of standard design details can accomplish this objective without having to draw the details each time they are used. If digital design data is used to drive numerically controlled production machines such as plate burners, pipe benders, or vent duct manufacturing machines, the digital data can be developed and checked once, then stored and used again and again. While storing and retrieving the data is not free, it is cheaper than creating the data every time it is needed.

MATERIAL AND EQUIPMENT STANDARDS

Material standards describe items of material and equipment which meet a wide spectrum of application requirements, and have been found through experience to meet the cost and performance objectives of the shipyard. Standard material items can be a direct result of standard design details, which should be used in every case where applicable. Raw material standards are usually mandatory or obligatory standards in the shipbuilding industry, and are specified by referencing industry, national, or classification society standards.

Material standards if followed from contract to contract will result in material and equipment being purchased which the buyer and installing trades are familiar with from prior experience. Material standards carried from contract to contract will permit larger quantity purchases resulting in better prices and lower administrative costs. For example, some shipyards have elected to standardize on a high grade bolt for all applications, thus reducing the number of types of bolts stocked, and avoiding rework and disruption caused by the inadvertent installation of lower grade bolts in locations where the higher grades are specified. Another shipyard involved in commercial shipbuilding stocks only schedule 80 pipe. This shipyard believes that the higher cost of the schedule 80 pipe is more than offset by reduced amounts of material in stock at any time, and reduced mistakes, rework and disruption caused by the pipe shop accidentally picking the wrong schedule of pipe. Other shipyards avoid the use of 3-1/2" and 5" pipe sizes for certain materials due to the high unit cost of these infrequently used sizes.

Purchased parts include all items that are designed and manufactured in accordance with external standards. These external standards include those established by industry groups, national standards organizations, and government agencies. Parts bought by the purchasing department are usually specified to conform to a relevant external standard. As a result of specifying purchased parts by reference to external standards, they are the easiest to standardize. However, because of the ease of specifying an external standard, they are also the most susceptible to "gold-plating" by specifying a standard that is more costly than is really necessary. Engineers and designers are human in their tendencies to take the path of least resistance, and to avoid risks by "beefing it up" when a bit more effort could result in a more economical choice. Engineering managers should be alert for tendencies to specify a standard that provides more than is required if a less expensive standard will do the job.

Certain types of equipment are good candidates for standardization. For example, a 500 GPM fire pump is always a 500 GPM fire pump, no matter what ship it is being installed in. Other examples include steel plates and shapes, threaded fasteners, electrical components, motors, controllers, and cable. Purchasing all electric motors from one manufacturer can frequently reduce the total cost of motors for a ship, as compared to buying motors individually for each application.

While it may be obvious that items that represent a large expenditure to the shipyard should be standardized, it may not be as obvious that low cost items purchased in large volumes should also be covered by standards. Consider the bolts and nuts example discussed previously. While these are relatively low cost items, they are purchased in large volumes. Proliferation of sizes, thread pitches, finishes, and materials can be reduced by a standard that requires selection from a limited number of choices.

One of the objectives of standardization is to require engineers and designers to select a limited number of parts from the variety available. This is accomplished by preferred and non-preferred parts standards. The examples cited previously, such as nuts and bolts, pipe, electrical cable, motors, etc., are all good candidates.

Loyalty to preferred suppliers can result in suppliers that are loyal to the shipyard, with improved delivery schedules and quality, and reduced costs. Unfortunately, U. S. Navy contracting practices generally require competitive bidding, which can make it difficult to establish a base of loyal suppliers because each purchase is evaluated independently, rather than as part of an over all long term business arrangement.

A few words of caution should accompany the subject of preferred suppliers. First, any long term business arrangement should be reached through reasonable competition. Second, arrangements should be for a definite period of time, after which they are reviewed and renegotiated to keep the forces of competition alive.

A standardized bid-response package should be part of the material standards program. Standard purchase order terms and conditions, and check lists of items to be furnished are essential to efficient processing of requests for quotations and award of purchase orders. The standards should include required delivery dates for drawings, test reports and other quality assurance documentation, and technical data such as technical manuals and spare parts lists.

It has been the experience of the authors that detailed design schedules frequently suffer from late receipt of equipment drawings. Early delivery of vendor drawings to support the shipyard's detailed design schedule is a valuable benefit of material/purchasing standards which provide standardized bid packages. Advance business arrangements with preferred suppliers are especially valuable in aiding timely delivery of equipment drawings. It has been the author's experience that few if any vendors will provide installation drawings before a formal purchase order has been awarded. This bottle neck could be alleviated with an advance business arrangement or contingent purchase agreement negotiated with suppliers during the bid preparation phase of the project. If advance agreements are in place, equipment drawings can usually be delivered in a matter of a few weeks, otherwise it typically takes several months before equipment drawings are received by the ship designers.

The importance of equipment drawings to the overall ship design and construction schedule cannot be over emphasized.

Without equipment weights, centers of gravity, and the pattern and size of hold down bolts, the ship designers cannot design equipment foundations. Without approximate heat rejection data, the heating and air conditioning designers cannot calculate loads to size the heating and air conditioning plant and ventilation fans. Without details of the fluid flows, electrical loads, and the sizes and types of piping and electrical connections, the fluid systems and electrical systems designs cannot proceed. Of course, one can make assumptions (usually conservative or over designed) or base the designs on data from previous projects, but this nearly always leads to excessive changes late in the design phase, with increased design costs and numerous opportunities for configuration control and design interface errors.

Shortening the design schedule, and reducing design costs and the opportunity for errors is a primary motivator to standardize and select equipment suppliers in advance whenever possible. In fact, most equipment suppliers, once selected, will make their applications engineers available to assist the shipyard engineers and designers in selecting the exact model and options best suited to the anticipated application, with a corresponding reduction in the cost of the ship.

Standards selected by the shipyard should flow down to the equipment suppliers. Standards to be met by the supplier should be spelled out in the sub-contract or purchase order, otherwise the over all system design could be seriously compromised. If the equipment supplier has been selected through an advance arrangement, the supplier’s applications engineers should participate with the shipyard engineers in specifying the standards to be met so that arbitrary decisions do not cause increased costs or result in unacceptable performance. In fact, participation of the equipment manufacturer’s applications engineers can be required as part of the advance agreement.

In summary, standardization of purchased parts, materials, and manufactured equipment can reduce the cost of purchased items, shorten design time, reduce design costs, and reduce the amount and variety of material in inventory. The cost of purchased items typically represents roughly 60 percent of the cost of a ship, hence standardization of purchased items represents a significant opportunity for cost avoidance. In addition, the logistic and life cycle costs to the owner are usually reduced.

PRODUCTION PLANNING AND CONTROL STANDARDS

The production planning, estimating, scheduling, and control functions are heavily influenced by labor productivity standards. This is true if the standards are part of a formal Standards Program, and it is equally true if the "standards" exist only in the form of informal notes in a production planner's personal files.

The building strategy is the foundation for the overall production planning process, and this strategy is usually subjected to fairly close scrutiny by shipyard management. However, once the build strategy is established, the detailed planning and scheduling is driven by the labor estimates for each work package. The labor standards used for estimating and scheduling should therefore be subject to equally close scrutiny by shipyard management. Are labor estimating and productivity standards based on accurate historical data, and are the standards formally approved by shipyard management?

The subject of labor productivity standards has received considerable attention during the past decade. A number of publications and reports are readily available from the National Shipbuilding Research Program library at the University of Michigan Transportation Research Institute, as well as from other sources. References [13], [14], [15], and [16] provide considerable insight into the use of standards in the production planning and scheduling process, in shipyards of all sizes. Reference [17] discusses techniques particularly applicable to small shipyards, and reference [18] provides insight into the application of group technology and master scheduling techniques. References [19], [20], and [21] report on the application of labor standards in specific trades. Reference [22] is an extensive discussion of the integration of the production planning and scheduling process with the cost/schedule control system in the shipyard.

The work instructions and technical documentation included in the work packages are particularly important to efficient utilization of production labor. Again, the germane questions are, "Is all necessary information provided?" and "Is all information provided actually necessary?" Extraneous information can lead to confusion and cause just as much delay on the water front as missing information. In either case, water front supervisors will be spending their time clarifying the intent of the planners, while the supervisor's crew may be standing idle waiting for the answers. The worst of all information is wrong information, which can cause the production trades to complete a task incorrectly, which is followed by expensive rip out and rework. Standardization of the production planning and scheduling process and the work package contents, and a formal work package checking process, can significantly improve water front productivity.

PRODUCTION / MANUFACTURING PROCESSES STANDARDS

Production Standards (manufacturing processes and assembly procedures) are another fertile area for standards in many shipyards. Production standards describe methods for performing repetitive tasks which have been found to meet the cost and performance requirements of the shipyard.

Standards for production define the usage, types, size or weight range, applicability and/or limitations of the sub-assembly and/or assembly, and establish the assembly/erection sequence. Manufacturing standards define the fabrication methods to be used. The only difference between manufacturing and assembly standards is the stage of construction at which the standards are invoked.

Production standards are necessary to document how certain tasks are to be performed to assure that the completed work meets the specified quality requirements. Many commercial ship specifications require the work to be "first class in all respects" and in accordance with the shipyard's "best commercial practice." It is incumbent upon the shipyard to define their best commercial practice by written standards. The alternative is to allow the ship owner’s representative to define what is or is not "best commercial practice." The ship owner’s definition may occur after the work is completed and if the work is found to be unsatisfactory in some respect, may result in less than desirable financial consequences for the shipyard.

Prudent use of production standards will reduce cost in at least two ways. First, they reduce the cost of rework by helping to ensure that the job is done right. Second, the use of production standards capitalizes on the learning curve benefits.

The work defined in work packages prepared in accordance with production standards must be followed to ensure that the work actually performed by the production trades correlates with the work planned in the work package. This is essential because schedules and budgets are based on accomplishing the work defined in the work package. If the work actually accomplished varies from that planned in the work package, then the budget and schedule tracking systems will be reporting progress based on completion of the work package, while the actual progress will be something different. This variance can degrade the ability of the shipyard to control costs. Reference [22] is an excellent discussion of the importance of integrating production planning with the cost/schedule control system. The point is, the beneficial effects of work packages based on standard production and manufacturing processes cannot be realized if the production personnel do not work in accordance with the standard work packages. Thus, it is critical that production (and productivity) standards used by production planning and control functions to prepare work packages be subject to review and acceptance by the supervisors and workers who will have to perform to the standards.

The importance of getting the production personnel involved in setting productivity standards cannot be over emphasized. The National Shipbuilding Research Program has sponsored considerable research into this consideration during the past decade. References [23], [24], [25], [26], and [27] have reported beneficial results obtained by getting the production employees involved in productivity improvement projects in several shipyards.

The types of shipyard standards discussed thus far are just a few examples of what can be standardized. Virtually any type of process can be standardized to some extent. This includes engineering selections, drafting, specifying materials, purchasing and stocking materials, fabrication and assembly processes, quality inspections and administrative procedures. The next section of this report investigates the organizational and staffing requirements for a shipyard Standards Program.

ORGANIZATION FOR STANDARDS PROGRAM DEVELOPMENT

ORGANIZATIONAL CONSIDERATIONS

The mission of a Standards Program is to simplify the design, purchasing, manufacturing, and assembly processes in a shipyard through the development of standards. In chapter 2 of reference [1], G. H. Ritterbusch defines the primary functions of a Standards Program as follows.

1. Identify standardization needs.

   Monitor external motivators for standards, e. g, implementation of 1S0 9000, changes in law or regulations, etc.

   Keep pace with technology, e. g., use of high strength low alloy steel in shipbuilding applications.

2. Take appropriate action.

   Adopt or adapt existing external standards.

   Select appropriate sizes, grades, etc. from existing external standards.

   Identify existing high-use, high-payoff items as preferred.

   Prepare new internal standards when needed.

   Assure technical validity of standards for particular applications.

3. Distribute and maintain standards.

Update standards.
Maintain standards.
Provide index searches for user organizations upon request.

4. Implement standards.
Maximize usage.
Audit for usage of mandatory standards.
Implement standards program on an ongoing basis.

5. Other functions.
Train standards users.
Provide advisory services.

Marco R. Negrete and David E. Henise discuss the organizational and staffing requirements for a standards organization in some detail in chapters 4 and 5 of reference [1]. Applicable portions of these chapters are extracted and adapted to suit a shipyard operation in this section. Specific line-by-line citations have been omitted only to improve readability.

The Standards Program organization should be a reflection of a shipyard's unique environment, with a view toward accomplishing, within that environment, the primary functions listed above. The degree of formality selected for a Standards Program organization should be appropriate to a shipyard's intended market, and should consider a shipyard's plans with regard to obtaining 1S0 9000 certification. If 1S0 9000 certification is not planned, a Standards Program can be relatively informal. If 1S0 9000 certification is planned, a formal Standards Organization will be more appropriate.

The ideal organizational location for a formal shipyard Standards Group would be similar to that of the Engineering Department or Quality Assurance Department. The Standards Group should enjoy the confidence of the entire company and not belong to one group with a vested interest in its functions. The Standards Group must be perceived as a company asset, and not just a departmental asset. The Standards Group should report to and be supported by Shipyard Management at a level similar to the Engineering or Quality Assurance Department in order to enjoy the visibility and influence that is essential to success.

A plan to ensure that standards are developed and implemented is a prerequisite to an effective shipyard Standards Program. The question of what should be standardized will affect the Standards Program organization chosen for a shipyard. The key to successful standardization depends heavily on defining appropriate objectives and organization for the standardization function. If the objectives are properly defined and the organization is properly formed and armed with a valid charter from top management, then the chances of successfully getting standards developed, and getting them implemented the way management wants them to be implemented are greatly improved.

A small shipyard may not be able to justify the capital investment required to acquire standards data bases and distribution systems. This limitation should not be a deterrent to establishing a Standards Program. Selective use of external national and industry standards, and a limited number of internal standards to specify preferred sizes, materials, finishes, etc., can be made available by placing hard copies in loose leaf binders located near the users. Reference [17] provides additional discussion of methods and technologies particularly suitable for small shipyards.

Once a shipyard decides to have a formal Standards Program, the organizational structure should be chosen to suit the size of the shipyard and other unique factors such as the number of shipyard sites and their relative geographic locations, availability of personnel, accounting practices, etc. What is appropriate and effective for one shipyard may be inappropriate for another. The shipyard's management philosophy should be taken into account as well as the number and locations of shipyard divisions which will participate in or be affected by the Standards Program.

In forming a standards organization, it is essential to establish a shipyard policy that clearly defines the charter of the organization and outlines what is expected from other groups within the shipyard. The policy/charter should provide a method for finding solutions rather than imposing a pre-define set of solutions. It should identify the rationale from which the standards organization's mission and objectives can be derived. It should also identify interfaces with other shipyard groups so that decision making activities are integrated into the overall management structure of the shipyard. Shipyard top management should focus attention on the most critical areas and resolve high level issues. Otherwise it may be difficult to ensure that scarce and talented personnel resources are used most effectively to meet the objectives of management. To help ensure that scarce resources are used most effectively, the charter should define the scope of the standards activity. Once the scope of the activity has been determined, then priorities can be set. The process of defining the scope and setting priorities serves to focus the standardization effort.

The sample charter shown in figure 8.1 was developed for Du Pent Corporation, to guide the activities of their Engineering Standards Committee. This sample is presented in Chapter 10 of reference [1] by Charles C. Quarles.

CHARTER

The objective of the Engineering Standards program is to reduce capital expenditures and operating costs by developing and disseminating acceptable solutions to repetitive engineering problems.The solutions must provide an adequate level of safety, operability, and reliability at minimum cost.

The Engineering Standards Committee shall recommend and approve general policies for the conduct of the Engineering Standards Program. Committee members are to represent the interests of their organizations and act to improve the usefulness and the use of Standards. The policies of the Committee are administered by the Standards Group. Standards are developed and maintained by subcommittees responsible for specific engineering disciplines or areas of interest.

RESPONSIBILITIES

To fulfill the intent of the Charter, the responsibilities of the Engineering Standards Committee are to:

1. Provide qualified people and motivate them to serve effectively on Standards Subcommittees.
2. Through serial letter reviews, comment on and approve all new standards, major revisions, and cancellations.
3. Review and approve the work program and budget.
4. Take an active role in promoting the effective use of standards throughout the Company. This involves a thorough knowledge of the Standards Program and its objectives plus familiarity with the way standards are used.
5. Provide a means for communication in both directions and at all concerned levels in the organization.
6. Provide general liaison between the Standards Group and the department ***or*** division represented in such areas as security, book audit, special uses of standards, plant coordinator activities, and assignment of books.
7. Approve formation or disbanding of subcommittees to adjust the organization to changing requirements.
8. Assess subcommittee performance and act to improve effectiveness. It is the objective of the Committee that each member attend and participate in at least part of one subcommittee meeting every year.
9. Be alert to national standards activities and recommend participation where Du Pent’s interests can be represented effectively.
10. Take whatever action is required to fulfill the intent of the Engineering Standards Committee Charter.

Figure 8.1 Example Standards Committee Charter. [1]

Robert Toth offers a slightly different approach in chapter 13 of reference [1], using examples prepared by R. E. Monahan for Control Data Corporation. Mr. Toth’s suggested mechanism for initiating a Standards Program is through a policy statement from top management. Figure 8.2 provides an example. Regardless of the choice of a charter or a policy statement to initiate the Standards Program, a more broadly based document laying out the philosophy of the Standards Program may also be useful.

Figure 8.3 is an example of a company standards philosophy statement. This example was also taken from chapter 13 in reference [1].

With the standards organization defined, a charter or policy statement issued, and a standards philosophy defined, the next subject of discussion is how to staff the standards organization.

COMPANY STANDARDS POLICY

PURPOSE

The purpose of this policy is to establish a system of published standards which set forth approved constraints when it can be demonstrated that such constraints will facilitate more efficient use of manpower, equipment, and material in the development, documentation, manufacture, installation, and maintenance of quality products.

POLICY

This company shall establish company standards related to the development, documentation, manufacture, installation, and maintenance of its products. These standards when approved are an extension of the Company's Policies and Procedures. All employees and management are responsible to act within the established frame-work of the standards unless deviations or waivers are requested and approved. It is further the policy of our company that the company staff shall provide an overview of line activities to assure compliance with the standards.

RESPONSIBILITY

The Company Standards Organization, with the cooperation and support from concerned line and staff organizations, is responsible for the development, maintenance, and promulgation of all Company Standards.

The Vice-President, Operations, is responsible for maintaining and interpreting this policy and providing necessary implementation procedures.

Figure 8.2 Example Standards Policy Statement. [I]

COMPANY STANDARDS PHILOSOPHY

1. Company Standards are established to serve a useful purpose, such as to reduce variety, establish control, or simply to define specific requirements.

2. Company Standards serve the individual by eliminating the need for repetitive routine decisions. They leave the person more time or productive creative thinking. They do not restrict his growth or contribution to the company effort.

3. Company Standards serve as a unifying element among the divisions by clearly defining areas of agreement where a common inter face is necessary or beneficial to the company.

4. Company Standards are dynamic and reflect planned progress. Standards are planned to limit change in a dynamic world, but we recognize that to limit change for too long a period can be detrimental.

5. Company Standards must be consistent with the objectives of the Company. They must reflect the needs of the Company, but shall not be the lowest common denominator of agreement.

6. Company Standards reflect industry, national, and international standards to the extent that they satisfy the objectives of the company.

7. Company Standards are prepared by individuals or small groups who are most qualified in the subject to be standardized. Committees are used to discuss, modify, and recommend proposed standards but are used minimally in the creative effort required in developing effective standards.

a. Company Standards are adopted by consensus. Consensus does not necessarily mean unanimous acceptance. Recommendations are weig hed rather than counted.A significant objection of one organization sometimes outweighs all other affirmative recommendations. Or, sometimes minor negative comments are discounted in the face of affirmative recommendations of organizations that are vitally affected by the standard.

9. New Company Standards and revisions to existing standards may be proposed by anyone recognizing a need that is not being met. It is the individual who usually conceives, discovers, and inspires new direction. Therefore, the individual should have the opportunity to propose standards or changes to standards.

10. Recognizing that change invites problems, Company Standards are evolutionary rather than revolutionary when possible. Accordingly, the Company Standards Organization provides assistance to individuals and divisions when introducing and implementing new or revised standards in the company.

11. Adherence to Company Standards is the responsibility of all management in the company. Corn any Standards must be adhered to by all personnel individually and collectively if standardization is to truly exist and provide the desired benefit to the company.

12. The Company Standards Organization has a responsibility to company management to audit and call attention to unauthorized deviations from approved standards.

13. Recognizing that effective standardization is highly dependent upon effective communications, the Company Standards Organization strives for effective information flow through its standards, newsletters, progress reports, and personal contact. Similarly, it solicits pertinent information from individuals, departments, and divisions, to assist it in carrying out the standardization function.

14. Underlying all other reasons for standardization, the ultimate objective is increased profitability for the company. While increased profitability may not be immediate or easily determinable by accounting methods, it must be significant and describable.

Figure 8.3 Example Standards Philosophy Statement.

STANDARDS PROGRAM COORDINATION

Overall coordination of a Standards Program should be accomplished at the level of a major department head or vice president. The Engineering or Quality Assurance Department Heads/Vice Presidents would be good candidates due to the correlation between their regular duties and the duties of the Standards Program Coordinator. More Standards Programs are affiliated with the Engineering Organization than all other variations combined. Choosing the right person to manage the standards organization will show the importance that top management places on the Standards Program. An experienced person, who understands what needs to be done, and has the respect of other shipyard departments who will be sharing the work, should be chosen.

The duties of the Standards Program Coordinator would include the development of a standards implementation plan. The implementation plan should be issued as a company policy directive, defining the scope, development procedures, and use of standards in the shipyard. The implementation plan should be a plan of action for company wide activities to document the standard procedures and processes in use, and to update existing standards if necessary. The Standards Program Coordinator should develop monitoring procedures to ensure that the company policy directives are adhered to.

The Standards Program Coordinator should establish the numbering system to be used for standards. In fact, the numbering system, format requirements, and distribution of standards will probably be the subject of the first standard developed by a shipyard. The Coordinator should also develop a procedure for maintaining and updating all relevant domestic and foreign standards used as reference material by the shipyard, and should establish a periodic review and update cycle for the shipyard's internal standards.

The standards organization not only develops answers to questions raised by operating divisions, but also frequently has to generate the right questions to ask. The Standards Program Coordinator should be a person with an inclination to question the way things are done, and should have the ability to challenge and motivate shipyard managers to look for better ways to do things.

The Coordinator should be able to elicit cooperation from diverse individuals and groups, and should have the capacity to display initiative, balance authority, and accept responsibility. The Standards Program Coordinator must be able to cope with the natural human traits of resentment and resistance to change, and be able to serve as a catalyst for compromise and consensus.

In small shipyards the Standards Program will likely be the responsibility of just one person. In this situation, the person selected should be able to function as the Standards Program Coordinator and as a Standards Engineer as well. The one-person standards department will serve as a consultant to shipyard staff in the engineering/design, purchasing, production, and quality assurance departments. The consulting function will include interpreting standards and providing factual information. In order to be effective, the one-person department must be staffed by a person with experience and knowledge beyond the scope of one shipyard department in order to command the respect and credibility needed to be successful. Credibility and respect is important to any standards engineer, and it is absolutely vital to a one-person department.

The ability to translate thoughts and ideas to paper in the form of words and graphics is a skill that is important for standards engineers, and is essential for the one-person standards department. Technical expertise may be provided from other departments within a shipyard, but most of the actual standards writing duties, or at least the editing of the final version of finished standards will be accomplished by that one person. Individuals who have difficulty interpreting engineering drawings or expressing themselves clearly on paper would not be good candidates.

The personal qualifications for the one-person standards department are more stringent and difficult to match than for managers of larger departments who can call upon specialists. The administrator of a one-person Standards Program must be able to address a variety of technical issues, persuade other organizations to support the program, and see to it that company policy is implemented and enforced. Finding a person with sound technical credentials, excellent communication skills, and a personality that is part politician and part sheriff may be difficult, but the potential improvement in a small shipyard’s profitability can be dramatic when the right person is in place.

Figure 8.4 shows an example position description for a Standards Engineer, provided by David Henise in chapter 4 of reference [1]. This position description reinforces the type of qualifications discussed above with regard to Standards Engineers and Standards Program Coordinators.

POSITION DESCRIPTION

TITLE: **STANDARDS ENGINEER**

REPORTS TO: MANAGER, COMPAMY STANDARDS ORGANIZATION

FUNCTION:

Develops company standards and implements company, customer, national, and international standards. Examines existing and proposed components, materials, processes, procedures, and other activities to ensure that, as far as possible, standard practices and optimum procedures are used. Consults with design, research, production, manufacturing, purchasing, and other departments, and formulates methods and specifications in consonance with company standards and standardization practices.

EQUIPMENT AND MATERIALS USED:

personal computer, desk top publishing system, mainframe computer, supplier catalogs, company technical inputs, company established procedures, formats, and publications, ANSI and other external standards.

SCOPE: Throughout the Company and its divisions.

DUTIES AND RESPONSIBILITIES:

1. Participates in organized studies that are part of the company's Standardization Program; monitors data sources and external standardization activities, and works with functional organizations throughout the company as well as vendors and consultants to develop effective company standards, adopt external standards, and promote implementation of company standardization practices.

2. Reviews materials, parts, Components, and items of equipment to eliminate unnecessary variety while retaining suitable alternative choices. Reviews standards in light of improvements in materials, advances in techniques and changes in external standards and statutory requirements. Develops or arranges for the development and implementation of standards concerned with new concepts and original ideas as necessary.

3. Keeps abreast of company and divisional developments in standardization. Provides information and advice on standardization matters in his or her field. May represent the Standards Department on internal or external committees concerned with standardization or the development of standards.

QUALIFICATIONS:

Typically requires a bachelor's degree or equivalent in Engineering, Engineering Technology or Industrial Technology, or related discipline, and a minimum of four years related industrial experience.

Figure 8.4 Example Position Description for Standards Engineer. [1]

Since schools do not offer degrees in standards engineering, the shipyard will most often find their standards engineer within the shipyard. Because it is essential that the standards engineer be familiar with the operation of the shipyard, it may be advantageous to assign a practicing engineer from an existing department to staff the standards organization. Most of the time it will be easier to find a replacement for the vacated engineering position than it is to find a qualified standards engineer from outside the shipyard. The engineer selected should be someone whose abilities have been proven on a major project, and who shows concern for shipyard practices common to all projects.

The Standards Engineer should be an excellent communicator, with the ability to express the policies of shipyard management clearly and effectively. Standards tend to be pervasive and affect every part of shipyard operations. Decisions should be shared at every level, from the executive office down to individual workers. If there is a lack of information flow or discontinuity because of the Standards Engineer’s inability to communicate, then decisions made at the lowest levels can affect or even nullify decisions at higher levels. This is especially true in decentralized operations where the Standards Engineer may be required to function as a bridge across otherwise independent operations. Shipyards with several operational sites separated geographically stand to benefit more from improved communication than a shipyard where all functions are co-located.

STANDARDS PROGRAM ADVISORY BOARD

To be successful, standardization must be well integrated into the planning and decision making processes of a shipyard. Existing mechanisms for planning and control should be used wherever possible. It is important that procedures for planning and control of the standardization function be exercised as part of the overall management process, because arbitrary application of standards is not a substitute for good management practices. Standards can be a powerful management tool when they are applied within the context of good management practices. It is therefore important that the shipyard’s key managers participate in the standardization process. Participation is generally ensured by having the key managers serve on a Standards Program Advisory Board.

A Standards Program Advisory Board should be established to assist the Standards Program Coordinator in providing direction and assigning priorities. The Advisory Board should include the heads of all shipyard departments that will be affected by the standards, and the Supervisor of the Standards

Design Group (or the one-person department). The Standards Program Advisory Board should meet hi-monthly or more frequently as required to approve new standards prior to their issue, authorize the development of proposed standards, provide overall direction to the program and set priorities for developing and implementing standards.

STANDARDS DESIGN GROUP

When standardization projects are authorized, the actual work is usually accomplished by a project task group or Standards Design Group. In some cases a resident shipyard expert or outside consultant may be used to complete the project. In either case, the authors should be directed to consider adopting or adapting existing external standards before considering the development of a unique internal standard. If an informal approach can accomplish the objective, then it should be used in order to avoid the expense of a more formal approach. After all, the primary focus of standardization is cost avoidance rather than empire building.

The Standards Design Group described here seldom has the status of a full time department. The Standards Design Group should consist of a Departmental Standards Coordinator from each of the shipyard departments, a Standards Design Group Supervisor or Administrator, and Standards Engineers and Designers as required by the size of the project. These positions may be filled on a collateral duty basis, or on a full time basis, depending on the shipyard's environment and the development status of the Standards Program. For example, if there are few written standards in existence, and the shipyard has decided to pursue ISO 9000 certification, then personnel should be dedicated full time to the Standards Design Group until all planned standards have been developed and the initial issue has been released. On the other hand, i.f a shipyard is not pursuing 1S0 9000 certification and a significant number of standards already exist, then many of the Standards Design Group functions may be accomplished as a collateral duty.

A dedicated Standards Design Group Supervisor should be provided for the sake of continuity, in all but the smallest and least formal shipyards. Regardless of the level of permanent staffing of the Standards Design Group, it will be necessary on occasion to supplement the group with personnel on temporary assignments from various shipyard departments. These supplemental personnel will generally be the standards coordinators from the various shipyard departments, assigned temporarily to work on a specific standardization task.

One of the major contributions of Standards Design Group members on assignment from the operating divisions is their specialized technical expertise that could not be expected from a small or one person standards staff. Also, active task groups working on short term assignments tend to make effective decisions, particularly if they can depend on the standardization specialist to translate their ideas into properly formatted company standards. The cross-fertili.zation of disciplines in task groups fosters a give-and-take attitude that moves the work along faster and promotes pragmatic solutions. The resultant standardization actions are usually more acceptable to the user organizations since their designated representative participated in the process.

Another advantage of the task group method is that task groups frequently extend standardization into different functional areas without the need of additional staff. This enables the Standards Program to educate a number of key people on the why's and how's of standardization.

Ideally, those assigned to work temporarily on a standardization project task group should have the same personal, social, and professional characteristics as an ideal Standards Engineer. Usually, this is not the case. Members of an ad hoc task group are assigned because of their technical expertise or because the operations they manage are directly affected. They may not be patient, selective, diplomatic, and open-minded. They may not possess negotiating skills or know how to write specifications. They are assigned because they are experts in their field. The Standards Program Coordinator or Standards Group Supervisor/Standards Engineer can provide the interpersonal skills to coordinate the task group's activities and to compensate for any shortcomings within the group.

Standards Group assignments that warrant special consideration are the standards coordinators or representatives of the major departments, divisions or functional organizations within the shipyard. These individuals can make or break a shipyard Standards Program since they can promote or stifle standards implementation. As the primary communication link between their operations and the standardization activities, the divisional standards coordinators interpret and express the needs of their operations to the standards organization, and they communicate the results of the Standards Program back to their parent organization. David Henise has provided an example of a position description for a divisional or functional standards coordinator in chapter 4 of reference [1]. This position description is shown in figure 8.5.

POSITION DESCRIPTION

TITLE: DIVISION (OR FUNCTION) STANDARDS COORDINATOR

REPORTS TO: DIVISION (OR FUNCTION) MANAGER

FUNCTION:

Coordinate standardization activities within the division or functional organization and initiate, implement, review, promote, and maintain Company Standards through the manager of the Company Standards Organization.

SCOPE:

This person is responsible for coordinating and representing all division functions such as Engineering, Manufacturing, Quality Assurance, Marketing, Accounting, and Materials. If this person is a Function Standards Coordinator, this person represents that entire function, such as Engineering.

DUTIES AND RESPONSIBILITIES

1. Coordinate all Company standardization activity within his or her division or function.

2. Represent his or her division or function at required standardization meetings.

3. Circulate proposed new or revised standards submitted by Company Standards Organization for division or function review to all affected department managers including the division or function executive. Compile and return comments as directed.

4. Distribute copies of the standards newsletter and other promotional material to appropriate people in the division or function.

5. Maintain a complete set of standards and a small inventory of each for distribution in the division or function and a list of all individuals in the division or function who receive copies of standards.

6. Submit requests for development of new standards or revisions to the Company Standards Executive Committee.

7. Assist the Company Standards Organization with any standards audits in the division or function.

Figure 8.5 Example Position Description for DivisionStandards Coordinator. [1]

The concept of the organizational structure discussed in the preceding paragraphs is illustrated in Figure 8.6 It should be noted that this structure is conceptual in nature. Adjustments should be made as necessary to fit into the overall structure of the shipyard, while providing for the functions shown in Figure 8.6

With the discussion of Standards Program organization and staffing completed, attention will now be turned to the subject of cost/benefit analysis. How does a shipyard decide what to standardize? Is it worthwhile? Will it really improve the profitability of the shipyard? Following a discussion of cost/benefit analysis, the final sections of this report will discuss the process of developing and implementing standards, and establishing and operating a standards library to stock and distribute standards.

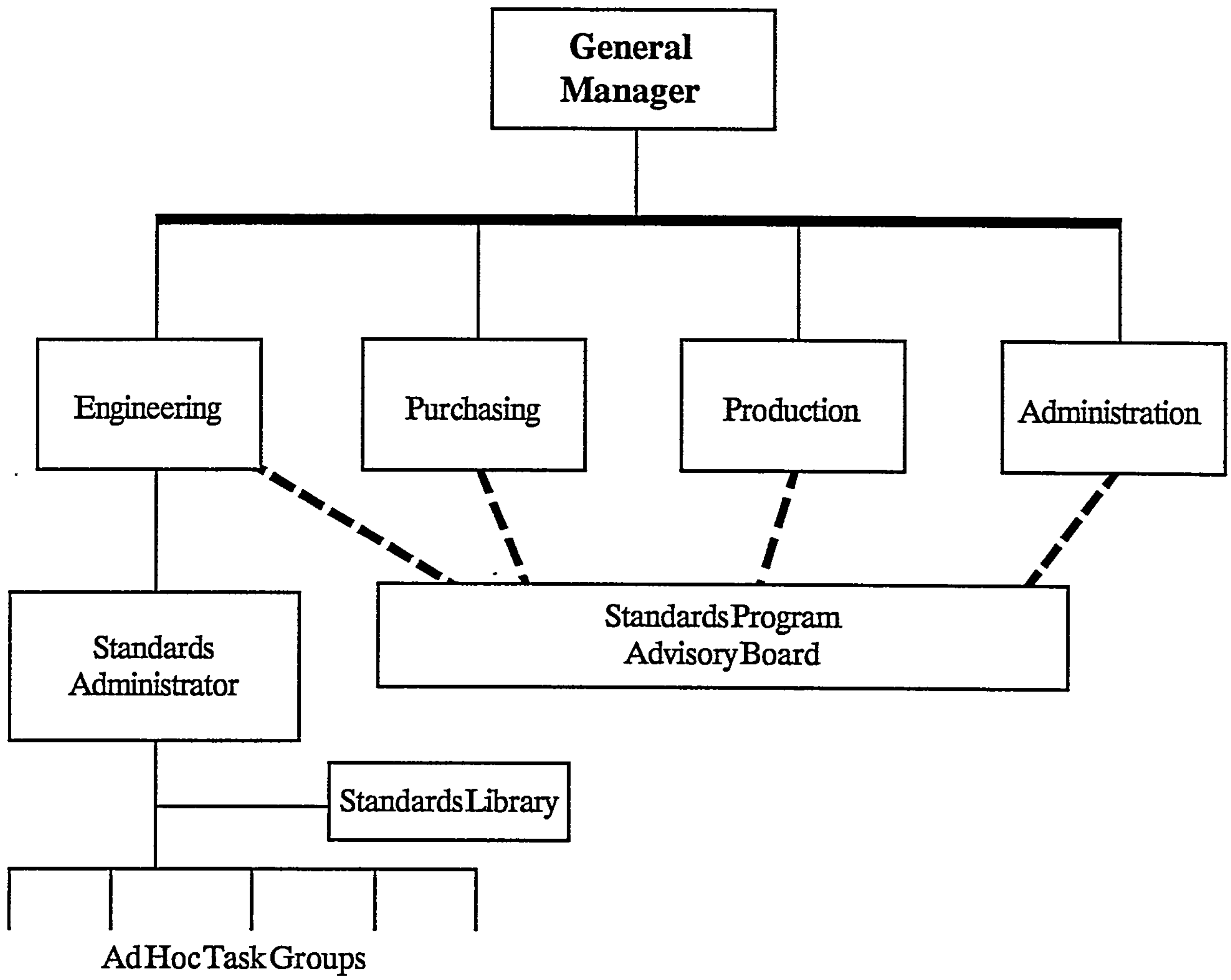

Figure 8.6 Example Standards Organization

COST/BENEFIT ANALYSIS

BENEFITS

Shipyard managers speak the language of money, and they are primarily interested in the return they can expect on the investments they make. While there is a general consensus that good Standards Programs can pay for themselves many times over, the benefits are frequently difficult to measure with the degree of accuracy demanded by shipyard managers. For example, the cost "savings" associated with a Standards Program are generally costs that are avoided. Cost accounting systems are designed to capture and report costs that are incurred. The question is, how does one capture and report a cost that is avoided? Imagine asking the shipyard comptroller to give you a report on how much money was NOT spent, how much material was NOT used, and how much time was NOT needed to complete a particular contract.

One way to determine the costs that are avoided is to estimate what the costs would have been without a Standards Program and compare the estimate with the actual costs reported by the cost accounting system. Alternatively, if a Standards Program does not presently exist, the actual costs without a Standards Program can be compared to an estimate of what the costs would have been with a Standards Program.

Either approach is dependent upon estimates which can be costly to prepare and are inherently subject to some degree of error. So how does one measure the benefits of a Standards Program?

The subject of standardization benefits and costs is covered in considerable detail in National Aerospace Standard 1524 - Standardization Savings, Identification and Calculation, published by Aerospace Industries Association of America. A copy of this standard is included as Appendix A, for ready reference. Shipyards may find NAS 1524 to be of considerable assistance in estimating the benefits and costs of a Standards Program. If NAS 1524 does not meet the specific needs of a particular shipyard, it can be modified or revised as needed to make it more applicable.

NAS 1524 lists 52 specific benefits of standardization. Some benefits are tangible; that is, they can be measured. Other benefits are intangible. Some of the benefits listed are "either/or" benefits rather than "and" benefits; that is, they are mutually exclusive. For example, consider the following contradictory statements.

> "Derive economies through special purpose machines performing standard operations, utilizing standard parts"

"Reduce the need for special tooling, training, layout and test."

Both benefits may accrue from a Standards Program; however, they cannot both accrue simultaneously to the same operation. Purchasing a special purpose machine to perform standard operations may initially increase the need for special tooling and training rather than decrease it.

If the benefits of a Standards Program are not readily measurable, then a qualitative method of assessment should be considered. Reference [28] discusses both quantitative and qualitative methods, and presents the qualitative method by evaluating the Standards Program as a service function in the shipyard, with the following list of services being provided.

1. The provision of authorized documentation covering all aspects of the organization, consisting of technical standards, procurement specifications, operational procedures, parts catalogs, administration manuals, etc.
2. Recognizing means of solving interface problems and creating company standards through a standards team which can identify problem areas, and through standards working groups to deal with particular problems.
3. Participation in the creation of national and international standards by providing representation either directly or on behalf of Trade Associations or professional bodies on appropriate committees.

4. Advising on the use of national and international standards, including legislative requirements, through internal bulletins/notices and disseminating the information as required.

5. Specifying parts. materials, equipment and production processes by means of classification and coding systems for application through all stages of production from the design stage onwards.

6. Exercising variety control to miriimize the number of parts, tyes of materials and equipment for the maximum number of purposes and the minimum investment in spares and material stock.

One or more of these activities will assist in the effective functioning of all the operations in a shipyard, such as Design, Purchasing, Production, Quality Control, and Administration. Above all, standards provide a means of communicating and imposing appropriate discipline on the operation of the shipyard. Standards provide both an initial statement of shipyard policy and a tool for measuring and controlling activities throughout the shipyard’s operations.

COSTS

Unlike the benefits of a Standards Program, the costs are readily measurable by ordinary cost accounting methods. Reference [28] lists the costs associated with a Standards Program in the categories of Investment Costs, Running Costs, and Fixed Costs. Investment costs include all expenditures associated with the development and presentation of standards, such as analysis, project definition and research, preparation, review and comment, and implementation costs. Implementation costs include the cost of preparing documents to incorporate a new standard into existing designs, re-tooling and retraining production personnel, and changes to production or inspection procedures. Revision costs are incurred whenever an existing standard is updated or corrected. Running costs include time spent interpreting details of a particular standard or advising users on applications, and the cost of adapting an existing standard to a new application. Running costs also include time spent determining a shipyard's needs for standards and monitoring new development-s in the Marine Standards field. Running costs are generally proportional to investment costs.

Fixed costs are incurred as long as a Standards Program is operating. One example of a fixed cost is the expense of establishing and maintaining a Standards Library. These costs are not directly proportional to the number of standards projects that may be underway at any one time. Fixed costs of a Standards Program should be apportioned in accordance with a shipyard's current practice. They could be apportioned to each standardization project in accordance with each project's Investment Costs, or they could be apportioned to the departments that benefit from the Standards Program, or they could be included in the general overhead account.

In summary, Standards Program costs can be distributed among the categories listed below.

1. Investment Costs
   a. Standards Development
   b. Standards Presentation
   c. Standards Implementation
   d. Standards Revision

2. Running Costs
   a. Advisory Service for Specific Applications
   b. Adapting Standards to a Specific Project

3. Fixed Costs
   a. Standards Library
   b. Participation in National and International Standardization Activities
   c. Training for Standards Staff
   d. General Advisory Services
   e. Training of Shipyard Staff
   f. Supervision

Two examples of cost/benefit analysis are shown on the following pages to illustrate the methods given in National Aerospace Standard 1524. After presenting these cost/benefit examples, the next section of this report will address Standards Program operating procedures.

COST/BENEFIT EXAMPLES

COST/BENEFIT EXAMPLE 1.

A shipyard installs 200 manhole covers each year. Would it be advisable to develop a standard design detail for manhole covers rather than detail each manhole on the structural drawings? The following costs are estimated. It takes about 18 minutes to detail a manhole cover on a structural drawing, and another six minutes to check the detail. To look up and specify the correct manhole standard would take four minutes, and another two minutes to check the choice. It will take about 20 hours to develop and implement a man hole cover standard detail. Engineering costs are $35 per hour, fully burdened. Referring to NAS 1524, Section 5.9, for guidance, the following analysis is appropriate.

$$s=R_d[N(H_{d1}-H_{d2})-H_{es}]+y$$

Where:

- s = Potential first year saving from standard detail.
- N = Number of applications on engineering drawings.
- H_{d1} = Estimated hours to detail manhole cover on engineering drawings.
- H_{d2} = Estimated hours to specify a design standard on an engineering drawing.
- R_d = Design rate per hour including overhead.

H_{es} = Estimated hours to develop the design standard.

y = Additional tangible or intangible savings

Thus :

$$s = \$35[200(.4 - .1) - 20] + Y$$
$$= \$1,400 + Y$$

Just the net savings from drawing costs avoided by using a standard detail amounts to $1,400 in the first year alone, with additional cost avoidance in each succeeding year. The variable Y can also be evaluated by the methods of NAS 1524. It should be noted that these are costs that will NOT be incurred if the standard is developed, and therefore will never show up in the cost accounting system.

COST/BENEFIT EXAMPLE 2.

A shipyard engineering department has 60 engineering and design personnel assigned. The Engineering and Design Standards Program is staffed with five people, at an annual cost of $364,000. The shipyard General Manager wants to eliminate the Engineering and Design Standards Program, and challenges the Engineering Manager to prove that it is cost effective. The Engineering Manager conducts a standards utilization audit and finds that each engineering and design person averages six searches a week for technical data on parts and materials (a total of 18,720 searches a year). Sixty percent of the searches are completed in six minutes each by finding the data in the shipyard's standards manuals and standard parts catalogs. Forty percent of the searches are completed in 1.25 hours each by finding the data from non-standard sources. The cost of design engineering is $35 per hour, fully burdened. The Engineering Manager prepares the following analysis, and cites NAS 1524, Section 5.4, as an authoritative reference for the analytical method.

$$S_{ys} = N R_c (T_{ef} R_s - T_{sm}) - C_{os}$$

where:

S_{ys} = Approximate net cost avoidance resulting from reduced search time as a result of standards.

N = Annual number of searches for data that could be expected to be found in the Standards Manuals, Parts Catalogs, etc.

R_c = Engineering rate per hour, including overhead.

T_{ef} = Time required to complete search for data that is not found in the Standards Manuals, Parts Catalogs, etc.

R_s = Success rate in finding data in Standards Manuals, Parts Catalogs, etc.

T_{sm} = Time required to accomplish the search when data is found in the Standards Manuals, Parts Catalogs, etc., including travel time to and from the Technical Library.

C_{os} = Annual cost to develop, publish, and maintain the standardization documents.

Thus: :

$$S_{ys} = 18720 \times \$35\ (.6 \times 1.25 - .1) - \$364,000$$

$$= \$61,880$$

The conclusion is that the five personnel assigned to the Engineering and Design Standards Program achieve a net cost avoidance of $61,880 each year that the Engineering and Design Standards program is maintained at the present level, considering <u>only</u> the reduced engineering time spent searching for data. Additional cost avoidance is achieved by the design group in reduced drawing time; by the Purchasing Department in purchasing, receiving, and storing a reduced variety of materials; by the Production Department in working with familiar materials and design details; and by the Quality Assurance Department in reduced inspection and certification costs. These additional costs can also be calculated by application of the methods of NAS 1524 if additional justification is needed.

STANDARDS PROGRAM
OPERATING PROCEDURES

The procedures described in this section have been adapted from reference [1]. Selected paragraphs from chapter 1 by Carl Cargill, chapter 2 by Gerald Ritterbusch, chapters 3 and 13 by Robert Toth, chapter 5 by Marco Negrete, chapter 9 by Hubert Brown, and chapter 11 by H. William Ellison and Verne H. Simpson have been extracted and adapted to suit a shipyard Standards Program environment. Line by line citations have been omitted only to improve readability.

IDENTIFYING THE NEED FOR A STANDARD

Understanding top management's goals is important in establishing a standards initiative. Whether the goal is compatibility, quality, cost, productivity, or some other initiative, it sets the priority in which problems are addressed and determines the vantage point from which the standardization effort must operate.

When considering a standardization proposal, the first decision faced by a Standards Advisory Group is whether to adopt an external standard, adapt an external standard to meet the shipyard's special needs, or develop a standard unique to the shipyard. If an existing standard can be found that meets the shipyard's needs, then adopting this standard will provide the most timely and cost-effective solution. Adapting an existing standard is also relatively quick and easy. For example, many existing standards for parts offer more choices than the shipyard may want to make available to their designers. This problem is easily solved by creating an internal standard that establishes a limited, or preferred, selection of parts from the existing standard. Where international, national, or industry standards exist, it is reasonable for the shipyard standards organization to acquire these standards and adopt or adapt them.

An even more cost-effective technique is to standardize without formal standards. Designating proven products, practices, and processes as preferred for use in the shipyard comprises the most basic type of standardization. Most shipyards do this without a formal standardization program. For example, "Everybody knows all our generator sets use the same alternators," or "We always buy zinc coated bolts." The shipyard can take the first steps toward a comprehensive standardization program by simply recording these decisions in a convenient reference document that can be distributed to those who make decisions about these items.

If no existing standards contain exactly what the shipyard needs, it may be necessary to develop a new standard. At this point the Standards Program Advisory Board should ensure that other alternatives have been investigated. Is it technically and practically feasible for the shipyard to develop a new standard? Existing standards establish a field of competent and competitive suppliers. Does the shipyard wish to operate outside of this established field of expertise? Use of an existing standard helps ensure that the parts or equipment covered by the standard are well designed and usable. What assurance does the shipyard have that their ideas will be as well designed and practical? It may be that a collaborative standard development effort working with a reputable supplier would be preferable to an independent initiative. A shipyard should develop its own internal standard only after a thorough search determines that external standards are not available, or would require modifications too extensive to justify adapting the standard to meet the shipyard's needs.

In general, a standard may be proposed by anyone - an individual expert, a task group, a supplier, or a shipyard department recognizing a particular need. Some form of written notification should be used so that all concerned parties are made aware of the proposal. This notification can take practically any form, and should be kept simple. The main goal at this point is to convey as simply as possible the need for a standard, and generally what the proposed standard will cover.

The second step in the process is to analyze the proposal. The Standards Program Advisory Board should accomplish this analysis with support from one or more technical specialists or experts in the field of the proposed standard. The analysis of the proposal is intended to clarify and focus the need for the proposed standard. What exact problem wi11 the proposed standard solve? Who will benefit if the standard is adopted? Are there potential cost savings (avoidance) if the standard is adopted? Can these cost savings (avoidance) be measured? If not, what is the estimated cost avoidance? Are there any potential added costs to implement the proposed standard and what are they? Who will be negatively affected by the proposed standard? These and other questions appropriate to the shipyard should be asked and answered by the Standards Advisory Board. These questions and answers should form the basis for the Advisory Board's recommendation to top management. Assuming a favorable recommendation, top management should be asked to formally authorize the development of the proposed standard. After all, it is the top management that is responsible to the shareholders, so they should authorize any investment that is intended to improve the shipyard’s profitability.

PRIORITIZING PROPOSED STANDARDS

The Standards Program Advisory Board should select the initial standardization efforts carefully. Standardize ation projects that will yield significant benefits in a reasonable time frame, and that are viewed as highly desirable at all organizational levels should be chosen first. The selection and implementation process should proceed in a manner that builds user support and utilizes the expertise of the users. It is good to plan for the future, but the initial effort should start at a manageable level and then grow through success.

A shipyard should set the highest priorities on the high-return opportunities, and leave other ideas for a later effort. Above all, a Standards Advisory Board should avoid the temptation to over standardize, keeping in mind that shipyard personnel must be allowed some flexibility, and that every standard adopted must be maintained.

Focusing the standardization effort is an iterative process of defining areas to be covered and setting priorities so that efforts can be adjusted to get the best overall results as demands change. A useful approach is to prepare and maintain a list of a shipyard's ten most significant problems. These problem definition statements should then be listed in descending order of importance to the shipyard. To establish the order of importance, consideration should be given to purchase or manufacturing cost, quality and reliability, reject rates, skill levels required for difficult operations, and other factors. A final list of top-ten problems should then be prepared and reviewed with all those who contributed to the list. The Standards Advisory Group should then decide which problems can be solved by a standard. With this feedback, the Board will have the foundation for an operating plan that can be applied with confidence.

As standardization action is completed on each problem, the Standards Program Advisory Board should add another to the top-ten list. In this process, the Board should be alert for changing conditions such as new regulations or legislation that may suddenly alter projects under consideration and their ranking on the top-ten list. The process of periodically updating the list is effective not only in focusing on real standardization needs, but also in assuring continued communication with key people throughout the shipyard. For example, a file of old top-ten lists is an excellent means of communicating past accomplishments of the Standards Program.

A well defined process of determining what to standardize, and in what order, will avoid problems that develop when management makes decisions without a formalized standards planning process, or sets priorities by intuition or by "oiling squeaking wheels." The tendency of a new Standards Program that is responding to "squeaking wheels" is to try to do too many things, with the result that very little actually gets accomplished.

PROCEDURE FOR DEVELOPING AND IMPLEMENTING STANDARDS

After management has approved the priorities recommended by the Advisory Board, the development of a draft of the proposed standard can begin. The draft can be developed best by an expert in the field of the proposed standard. Committees and Boards are excellent for authorizing standards and setting priorities, but the creative work of developing a draft is best accomplished by one or two experts who collect inputs from each area of the shipyard that will be affected by the standard.

The permanent standards organization should help with details such as formatting, interpreting existing standards and standards policy within the shipyard, and procedural considerations. The champion of the proposed standard should be involved since this is the best way to ensure that the development will proceed expeditiously.

Standards should be formatted and published in a professional manner. The Standards Engineering Society has prepared a guideline format for standards which can be tailored for application to a shipyard’s internal standards. Ordering information is included in Appendix B. Keep in mind that the goal of the Standards Program is to ensure the broadest possible use of the shipyard’s standards, therefore the presentation has to be clear and must cover all the necessary information. Clear and concise scopes or abstracts should be provided. The technical material should be arranged so that the meaning is as clear as possible. Writers should not assume that the user is familiar with the topic. References should be included where they may be helpful.

The development process can be aided by using as many sources of information as possible. It is easy to eliminate redundant or inappropriate information as the development process continues. In addition to external sources such as national, international, and industry reference standards, the views of individuals who will be affected by the standard should be solicited. These would include key people from engineering, purchasing, production, quality assurance, and shipyard administration. When all the relevant information has been gathered and the concerns of affected departments have been obtained, the actual writing process can be started.

Building a consensus is essential to successfully implementing a new standard. Once the draft standard is available, it should be circulated for review and comment to all persons concerned. Division or Department Standards Coordinators should be responsible for circulating the draft within their departments and collecting all comments. Ultimately, the departments most affected by the proposed standard will have to implement it, so they should show a keen interest in the contents of the proposal. When all comments have been received, a formal review meeting should be convened, with all reviewers present to explain their concerns and to hear about the concerns of others. The results of this formal review should be a consensus that everyone can accept.

Following the formal review and establishment of a consensus, the final draft should be developed. The final draft should be as close to the final format as possible, with professional word processing, graphics, and printing. The final draft should look final in all respects in order to avoid unnecessary additional comments on editorial matters. The quality of the finished standard will be a definitive statement of the importance of the document, and will affect the degree to which the standard is accepted and implemented in the shipyard. Expensive covers and binders are not necessary, but the editorial work, graphics, and readability of the standard should be first class. The final draft should serve as a test document to determine if the intended users can understand the standard and properly apply it.

When adequate review of the final draft has been completed, the standard should be formally approved and issued. At this point, it should be emphasized that standards may be developed by consensus, but they are implemented by mandate. The implementation should be by a directive signed by the top management official in the shipyard. The directive should be distributed to every person affected by the standard, and if the standard is not too bulky a copy should be attached. While some may question the expense associated with providing a copy to every one concerned, keep in mind that if a copy is not provided with the directive, then the first thing that every one concerned will do is go to the library and get a copy for their personal use. It is much more efficient to bulk print copies for the initial distribution.

The process of developing an internal standard is illustrated in flow diagram form in Figure 10.1.

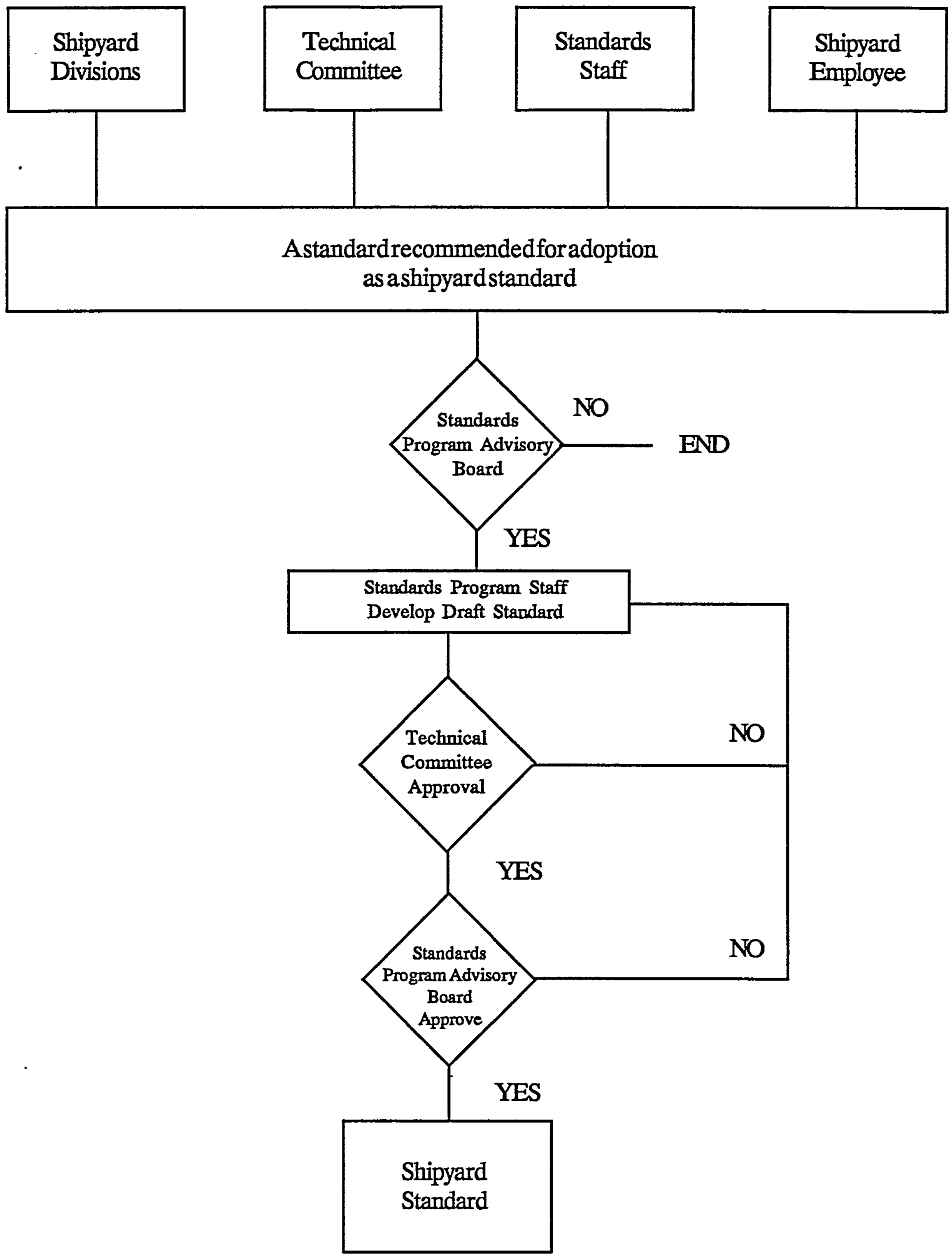

Figure 10:1 Flow Diagram of the Standards Development Process [1]

One of the real dangers in developing standards is that the standards may have the effect of freezing technology at the level of the standard. To guard against this danger, and to ensure that the standard continues to meet all current and anticipated needs, a formal review and up-date process should be provided. This can be accomplished on a periodic basis, for example every five years, or by making a particular expert Or function responsible for reviewing and updating the standard as required by changing conditions.

When a standard is revised, the standards organization distribution system should disseminate the revision to the users. A dating or coding scheme is essential to distinguish the current issue. Many organizations use an additional letter following the standard designation to indicate the revision status. As a convenience to users, a vertical line in the margin is frequently used to identify lines or paragraphs that have been changed in the most recent revision. Sufficient details should be included to allow users to determine if the revision needs only to supersede the former issue, or if additional action may be required on the part of the user to implement the change.

MEASURING UTILIZATION

The measure of effectiveness of a shipyard's Standards Program is not the number of standards in its standards manuals, or the number of people involved in standards development. The real measure is the extent to which standards show up in ships built by a shipyard. This is also a measure of the real level of management support for a Standards Program. It is easy for management to approve a standard and direct that it be used, but day to day support for implementing the standards is what really makes a Standards Program work.

One measure of utilization is the number of requests submitted for a deviation or waiver of the requirements of a standard. This number should be monitored and tracked by the Standards Program Advisory Board. In addition, periodic audits should be conducted, using statistical sampling techniques, to ensure that deviations are not occurring without authorization. The independence and auditing experience of the Quality Assurance Department makes them a good candidate for conducting these audits.

Another measure of utilization is the number of requests for changes to existing standards. If there are few or no requests for changes, it is a sure bet that at least some of the standards are not being widely utilized.

In order to be utilized, standards must be readily available to the users. One of the best methods of making standards available is to regularly distribute an up to date index to the standards on file. The standards organization should be responsible for maintaining the index and publishing it on a periodic basis. If a standard exists, the user should be able to identify it quickly. If a standard is not listed in the index, the user needs to have confidence that the index is complete. Requests from users for special index searches is an additional measure of standards utilization. The standards organization should keep a record of the number of index searches requested, who requested them, and what type of information was requested. This information can be a vital link in determining the need for additional subscription services, or for initiating a new standard development effort.

USING FEEDBACK

Feedback from users of standards should be a high priority for the shipyard Standards Program to enjoy long term success. The standards organization, from the Standards Program Advisory Board to the authors of individual standards should keep in mind that their function is primarily a service to the user organizations, to help them perform better. The user organizations are the "customers" of the Standards Program, and should be treated as such at all times. Complaints about content, or accessibility or appropriateness of standards should be given top priority by the standards organization. A Standards Program that is implemented autocratically can damage the shipyard's productivity and profitability just as much as a good Standards Program can help. If the steps to developing standards are followed as outlined in this guide, especially the process of building a consensus for a standard before mandating that it be used, then the feedback should be primarily positive.

Feedback, both positive and negative should be actively sought out, and utilized to steer the Standards Program toward maximizing the positive aspects of standardization and minimizing the negative effects as much as possible. Open communications are essential in both directions, and it is critical that any negative feedback be given immediate attention by the Standards Program Advisory Board. Measurign the use of standards is important, but the enthusiasm with which standards are used is just as important to the long term health of the Standards Program. A few very modest standards, enthusiastically applied, can accomplish more than a complete set of sophisticated standards that are either not used or are used grudgingly.

STANDARDS PROGRAM LIBRARY

The information contained in this section is based on chapter 15 of reference [1] , written by Patricia L. Ricci. Selected portions of Ms. Ricci's work have been extracted and modified to apply specifically to a shipyard environment. Line by line citations have been omitted only to improve readability.

STAFFING AND BUDGET

The level of shipyard resources devoted to establishing and maintaining a standards library will vary greatly depending upon the scope of the Standards Program. At a minimum, the standards library should include a subscription to a standards information service, usually in microfilm cassette media, access to a reader/printer; file cabinets and storage shelving; hard copies of all internal standards and other frequently used reference documents, including superseded versions if available; a personal computer and data base software, printer, and modem; a good copy machine, and a full time standards librarian to maintain the library and assist users in finding information. Even this modest library is not an inexpensive undertaking, but it will be substantially less expensive than not having a library.

A standards library will be of service to all of the departments in a shipyard, and will be a particularly valuable resource to the engineering department. Not having a central library means that user organizations will have to maintain their own files of standards information, which will ultimately be more costly and less effective.

Typical investment and operating costs for a modest standards library would include the following items.

Investment costs:

File cabinets and shelving.	$5,000
Microfilm reader/printer.	$10,000
Personal Computer, software, printer, modem.	$5,000
Copying machine.	$10,000
Investment cost sub-total	$30,000

Annual operating costs:

Staff information specialist, fully burdened.	$50,000
Subscriptions for information.	$30,000
Miscellaneous supplies and services.	Suu2!2
Annual operating cost sub-total	$85,000
Depreciation of investment, 5 yr. straight	S&JM2
Approximate annualized cost of standards library	<u>$91,000</u>

Note that costs can be reduced significantly in a small shipyard by time-sharing of equipment, and particularly by time-sharing of personnel.

The ideal standards librarian would be a trained information specialist with a degree in library science and experience in standards. Depending on the size of the collection, a clerical person may also be needed to maintain the order of the collection, process orders, make copies, and cover absences of the information specialist. The cost of a professional information specialist will likely be the largest single operating cost, with the cost of subscriptions for standards information services following close behind.

ACQUIRING STANDARDS

One of the first questions to be asked is "What standards should be purchased?" A computerized listing of standards applicable to the marine industry is available from the National Shipbuilding Research Program at the University of Michigan, at NO COST. Appendix B provides the address to contact for additional information. Considering the cost of purchasing hard copies, it will probably make sense to purchase portions of complete sets of standards in microfilm media, because the purchasing, quality assurance, and engineering departments are always looking for information about standards called out in the contract specifications, and these standards vary from one contract to another. The following list of standards is suggested as a shopping list for commercial ship building activities, from which a shipyard can select those most applicable to its business. Military specifications, MIL Standards, and Fed Specs and Standards should be added if the shipyard is active in Naval shipbuilding.

Organizations Developing standards with Shipbuilding Armdications

American Society for Testing and Materials
American Society of Mechanical Engineers
American Petroleum Institute
Underwriter's Laboratories
Institute of Electrical and Electronics Engineer
National Fire Protective Association
American Society of Heating, Air Conditioning and Refrigeration Engineers
American Welding Society
National Electrical Manufacturers Association
Steel Structure Painting Council
American Bureau of Shipping
United States Coast Guard
Maritime Administration
Society of Naval Architects and Marine Engineers
American National Standards Institute
International Organization for Standardization
International Electrotechnical Commission

Indexes to the standards developed by these organizations will provide the shipyard with a comprehensive standards list from which it can select the sub-sections or individual standards of most interest. Most of these sets of standards can be purchased in sections to reduce subscription costs. If all sections of all sets listed above are obtained on a subscription basis, the annual subscription costs would be more than $60,000. Military specifications and Mi1 Standards would add roughly another $6,000 to the annual subscription costs. A more economical approach would be to obtain the indexes published by these organizations, and then select certain sub-sets or individual standards for inclusion in the shipyard standards library. Input from the intended user organizations should be solicited to establish the initial list of standards to obtain.

If the shipyard does not intend to develop many internal standards, and does not have an engineering department or utilizes engineering sub-contractors for most of their engineering and design work, then the list should probably be limited to just a few standards. If only a few external standards are used directly and there is no need for external standards as a general technical reference source, then hard copies of selected individual external standards would be less expensive than selected sections of sets of standards on microfilm. Shipyards should consult with one of the information sources listed in Appendix B to obtain comparative cost estimates before deciding which way to proceed. Most suppliers of standards offer a variety of media, e. g., hard copy, microfilm, CD ROM disk, etc. Also, some suppliers offer discounts for quantity purchases and combinations of sets of standards.

ORGANIZING AND CATALOGING

Knowing which standards are available within the shipyard and where they are is essential. The method chosen to catalog and organize the standards will depend on whether the standards are hard copy or microfilm, how many standards are on file, and the staff, money, and time available. One of the major advantages of collections of standards on microfilm is the excellent indexes and cross-references that come with a standing order or subscription. It doesn't take a very large collection of hard copies before an additional person would be needed on the library staff just to keep up the indexes and cross-reference lists.

For the smaller collections of internal (and external) hard copy standards, a simple card file may suffice. A master card for each standard, containing all pertinent information, possibly including a short abstract, is created first. Several additional cards are then made and are filed by the standard name, by the number assigned by the developing organization, e. g., ASTM 1234, by subject matter, etc. These cards refer the user to the master card that has more complete information about the document, including where it is located.

A computerized list of standards held by the library, combined with an automatic circulation system is the most advanced method of cataloging. Advances in personal computer capability make it attractive to develop a complete listing on readily available data base software that is capable of searching, sorting, and selecting documents by key word, identifying number, or other attribute in a matter of seconds. An additional data field for adding notes can be used to indicate superseded items, jointly developed standards, or items that are on order. This method requires considerable time to key in all the information, but it allows the greatest control and access to the standards on file.

STORING AND RETRIEVING STANDARDS

The standards on file must be arranged in some logical fashion so that items can be readily found. The needs of the users should take precedence over arbitrary classification schemes. It may be desirable to group standards according to categories such as: the shipyard's own standards, other company's standards, standards from domestic standards developing organizations, internationa1 standards, and multinational standards. The Ship Work Breakdown Structure (SWBS) numbering system works well for shipyards involved in Naval shipbuilding or repair work.

The actual physical arrangement of categories will be affected by several factors such as frequency of use, size of the collection, space available, and format. Microfilm cassettes should be located adjacent to the reader/printer. The standards used most often should be the most accessible. The Standards Engineering Society has developed a Recommended Practice for Designation and Organization of Standards, SES 001, which can be used for additional guidance.

A policy should be established to define whether and how long outdated standards are kept. Outdated standards should be labeled "old" or "superseded" and the superseding document should be identified. There are some advantages to keeping old copies. For example, an external standard that has been adopted as a shipyard standard may be revised by the organization that developed the standard, but the shipyard may not want to revise its practice Also, vessels under repair may have been built to a standard that is no longer in use. Maintaining the old standard be necessary in either case.

DISTRIBUTING STANDARDS

The standards library should have the primary responsibility for distributing standards to the user groups, and for publishing a periodic listing of the standards indexes and individual standards held in the library. Standards may or may not be available to be borrowed by users for use at their work places. If a suitable working area is provided in the library for standards users to conduct their research, and a copy machine is available for the user to make a copy of the item (s) needed, then a "no borrowing" policy may be appropriate. When standards are allowed to be borrowed from the library, it is necessary to keep a record of the name and location of the borrower. The traditional library book card works well for keeping track of standards which are out on loan to a user group. These cards are available from any library supply company. The method of filing the book cards should emphasize locating the standard rather than recalling overdue items.

The standards library should maintain close contact with all users. Maintaining visibility as well as providing quality service is essential to the library's mission. Publishing a monthly newsletter to list new additions and advise users of pending standards developments or a change in policy can be very useful, not only to the library but also to the user groups. If there is no time or staff available to publish a standards newsletter, then the librarian should prepare articles for inclusion in some other form of company wide communication. When the standards library is well organized and visible, it will have many useful functions within the shipyard and will play an important role in helping the Standards Program reach the objectives of management.

SUMMARY AND CONCLUSIONS

A shipyard Standards Program provides a valuable tool to reduce costs in normal shipyard operations. All shipyard personnel make decisions in the course of their daily duties. These decisions made in accordance with established standards in virtually every case. If the standards have not been established by conscious decisions, then they have been established by default by individual employees. The individual employee cannot be blamed for failing to comprehend the effect of a local decision-making "standard" on the overall shipyard effectiveness and profitability. It is management's responsibility to see that standards approved by management are provided to guide the daily decisions of employees to be most profitable for the shipyard.

Decisions should involve measuring or at least estimating the cost difference between using a formal approved standard, and using an informal standard established by the employees as the "normal way we do it." The decision to use a formal approved standard is a decision to incur certain costs now in return for the promise of avoiding costs in the future. The decision process revolves around the difference in cost between formally standardizing and informally allowing generally accepted practices to prevail.

The usefulness of standards as a powerful tool for shipyard productivity management cannot be overestimated. Not only do standards provide an initial statement of shipyard policy, but they also provide a mechanism for monitoring and controlling the daily operation of the shipyard. It is the authors’ hope that this guide will provide useful information and guidance in establishing Standards Programs that are appropriate to the environment within which shipyards operate and compete for business, with a balance between formal and informal standards that will lead to improved profitability and long term viability for the marine industry in the United States.

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APPENDICES

APPENDIX A NATIONAL AEROSPACE STANDARD 1524 - STANDARDIZATION SAVINGS, IDENTIFICATION, AND CALCULATION

1. SCOPE

1.1 Purpose

The practices established in this document provide uniformity in identification and calculation of the major identifiable cost avoidance and cost reduction savings factors resuiting from standardization projects.

1.2 Technical Requirement Identification

The practices detailed in this document protide for calculating savings and cost avoidance as a resuit of the following factors which *are* identified by their respective requirement identifiers:

NAS1524-1 Standardization Savings from Increased Quantity Purchases.

NAS1524-2 Standardization Savings in Paperwork and Handling.

NAS1524-3 Standardization Savings from Reduced Storage Requirements.

NAS1524-4 Standardization Savings from Reduced Engineering Search Time.

NAS1524-5 Standardization Savings from Using a Stocked Standard Part in lieu of Establishing a New Standard.

NAS1524-6 Standardization Savings from Using a Stocked Standard Part in lieu of a New Design.

NAS1524-7 Standardization Savings from Control and Reduction of the Number of Items in Inventory through Simplification or Use of a Supersedure Procedure.

NAS1524-8 Standardization Savings from Using a Stocked Standard Part in lieu of a Nonstocked Part.

NAS1524-9 Standardization Savings from Using a Design Standard in lieu of detailing the Data Completely on the Drawing.

LIST OF CURRENT SHEETS

3

No.	Rev	No.	Rev	No.	Rev	NO.	Rev
1	3	6	1	11	1	16	2
2	1	7	1	12	2	17	2
3	1	8	1	13	1	18	1
4	1	9	1	14	1	19	1
5	1	10	1	15	1	20	New

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CUSTODIAN National Aerospace Standards Committee

PROCUREMENT SPECIFICATION	TITLE	12AS81FICA710N
None	STANDARDIZATION SAVINGS, IDENTIFI CATION & CALCULATION	Standard Practice
		NAS 1524 Sheet 1 of 20

2. REFERENCED DOCUMENTS

2.1 Appendix 10 lists general useful references.

2.2 Appendix 20 lists Tangible and Intangible Factors to be considered in identifying and calculating standardization savings.

3. DEFINITIONS

3.1 Cost Avoidance

A decrease in the targeted overall cost for accomplishing a function. Such a decrease is made before actual cost figures are available for the product or service involved.

3.2 Cost Reduction

A decrease in the committed or established overall cost for accomplishing a function.

3.3 Economic Order Quantity

The order size at which the unit cost of purchasing and stocking an inventory item is at its lowest. To find the Economic Order Quantity (sometimes called the lot quantity or order quantity) it is necessary to calculate all costs connected with an order, including restocking costs and carrying costs.

3.4 Inventory Carrying Cost

The sum of those increments contributing to the expense of storing and maintaining a stock of items. Carrying cost increments usually considered are:

a. Interest on invested capital.
b. Insurance charges.
c. Cost of warehouse space.
d. Labor cost to maintain stock.
e. Cost of obsolescence, surplus, breakage, etc.

3.5 Cost of Establishing a New Item

The sum of those increments contributing to the expense of making a new item available for use in a system. These increments include:

a. Engineering time.
b. Drafting time.
c. Checking and release time.
d. Evaluation or qualification tests.
e. Preparation of initial procurement and stocking documents.
f. Preparation of initial inspection plans.

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4. GENERAL REQUIREMENTS

4.1 Major identifiable savings factors are presented for appraisal of standardization accomplishment. Only the primary savings factors have been identified and secondary factors have been omitted because of difficulty in calculation or lack of significance in savings potential. Appendix 20 lists the savings factors usually resulting from standardization action. Wherever possible, typical costs of doing business are included. The majority are the result of national surveys and the remainder represent the best information available at the time. Users are encouraged to test and modify the se factors to suit specific requirements and, should better data become available, provide these to the National Aerospace Standards Committee for subsequent revision of this standard practice.

For a more complete and detailed exposition of the principles covered in these standard practices see References No. 3, No. 5, and No. 6 listed in Appendix 10.

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5. DETAILED PROCEDURES

5.1 Standardization Savings from Increased Quantity Purchases. NAS1524-1

5.1.1 The savings attainable through standardization from increased quantity purchases may be estimated from the use of the equation:

$$\text{Cost Savings} = \text{Purchase Cost Part 1} + \text{Purchase Cost Part 2} + \ldots$$
$$S_qb = Q_1 c1 + Q_2 C_2 + \ldots$$
$$\ldots + \text{Purchase Cost Other Parts} - \text{Total Quantity Replaced Parts} \times \text{cost of Standard Part}$$
$$+ Q_n C_n - (Ql + Q2 + \ldots + Qn)\, CS$$

where:

S_qb = The cost reduction resulting from a quantity purchase and discount.

Q_I = The quantity of part 1 which would have to be purchased yearly if it were not replaced by standard part Ps.

c1 = The unit cost, in dollars, of part 1 based on the actual purchase costs in dollars.

Q2 = The quantity of part 2 which would have to be purchased yearly if it were not replaced by the same standard part Ps.

C2 = The unit cost, in dollars, of part 2 based on the actual purchase costs.

Cs = The unit cost, in dollars, of the standard part based on the increased quantities needed yearly.

5.1.2 Example

Yearly requirements for an aerospace program require 10,000 hose clamps costing 60 cents each and 20,000 similar clamps costing 70 cents each. Replacing the se clamps with an industry standard costing 50 cents each for the 30,000 required each year results in the following savings:

S_qb = 10,000 X \$.6O+ 20,000 x \$.70 - (10,000+ 20, 000) \$.50

= \$6000 + \$14, 000-\$15,000

= \$5000 per year

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5.2 Standardization Savings in Paperwork and Handling. NAS 1524-2

5.2.1 The savings attainable through standardization in paperwork and handling may be estimated through the use of the equation:

cost Savings	=	Reduction in Purchase Orders	x	cost to Process P. O.	+	Reduction in Shipments	x	COSt of Paperwork and Inspection
Spw	=	(N1 - N_2)		(K)	+	(D_1 - D_2)		(J + M)

$$S_{pw} = (N_1 - N_2)(K) + (D_1 - D_2)(J + M)$$

where:

Spw = Cost avoidance resulting from reduction in paperwork and handling .

N1 = Number of orders placed per year before standardization.

N2 = Number of orders placed per year after standardization.

The most economical number of orders that could be placed can be derived from the economic order quantity formula. (See References No. 2 and No. 4 in Appendix 10 for this derivation and other useful applications.) The most economical number of orders is expressed as:

$$N = \sqrt{\frac{IA}{2K}}$$

where:

I = Inventory carrying cost in decimals. (Aerospace industry average in 1966 was .18.)

A = Annual volume in dollars.

K = Purchase order average process costs. (Includes purchase orders and invoices. A typical average cost is $35.) (1)

D1 = Number of yearly shipments before standardization.

D2 = Number of yearly shipments after standardization.

J = Storage bin average cost (Paperwork only. A typical average cost is $16.)

M = Receiving inspection average cost. (Varies widely depending on commodity, but a typical average cost is $32.)

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5.2. Example

By applying the principles of standardization on an aerospace program the variety of electrical connectors is significantly reduced *resulting increased quantity* purchases of the preferred varieties with a resultant decrease in annual cost from $100,000 to $70,000. Savings in paperwork and handling can be estimated conservatively by assuming that the most economical number of orders will be placed and each order will be delivered as a single shipment.

$$N_1 = \sqrt{\frac{[illegible]}{2 \times \$35}} = \sqrt{256} = 16$$

$$N_2 = \sqrt{\frac{.18 \times \$\ 70,000}{2 \times \$\ 35}} = \sqrt{180} = 13$$

= **$105 + $144**

= **$249 per year**

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5.3 Standardization Savings from Reduced S orage Requirements. NAS 1524-3

5.3.1 The savings that can be achieved by reducing storage requirements as a result of standardization action may be estimated from the use of the equation:

$$\text{Cost Savings} = \text{Cost of Storage Space} \times \text{Reduced Space Requirements}$$

$$SS_p = C_{cf} \quad (V1 - V2)$$

where:

SS_p = Annual cost reduction accruing from reduced warehouse requirements.

C_{cf} = Annual cost to maintain one cubic foot of warehouse (An Air Force study, Reference No. 1 of Appendix 10, developed the average cost of 77 cents per cubic foot per year for aerospace components.)

V1 = Average number of cubic feet occupied during the year before standardization or simplification.

V2 = Average number of cubic feet occupied during the year after standardization or simplification.

Cost and space requirements may be calculated on the basis of square feet of storage space if more convenient.

5.3.2 Example

The standardization of hose clamps described & the example of NAS 1524-1 resulted in a reduction in storage requirements from 40 cubic feet to 16.

$$SS_p = .77\ (40 - 16)$$

$$= \$18.48$$

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5.4 Standardization Savings from Reduced Engineering Search Ti[me] NAS1524-4

5.4.1 The savings in engineering search time-as a result of the read[y] availability of standards manuals and similar aids may be estimated from [t]he use of the equation:

Cost Savings = Cost to Search W/O Stds. Manuals − Cost to Search Stds. Manuals With Success − Cost to Search For Items Not In Stds. Manuals [After First Looking in Stds. Manuals + Search in Engineering Files, etc.] − Cost to prepare and maintain Stds. Manuals

$$S_{ys} = N T_{ef} R_e - N R_e R_s T_{sm} - R_e (N - N R_s)(T_{sm} + T_{ef}) - C_{os}$$

which simplifies to:

$$S_{ys} = N R_e (T_{ef} R_s - T_{sm}) - C_{os}$$

where:

S_{ys} = Approximate cost avoidance resuiting from reduced search time as the result of standardization.

N = Annual number of searches for data that could be expected to be included in Standards Manuals, Preferred Lists of Parts, Materials, and Processes, etc. (A typical 1000 man project averaged 4000 searches per week in the design and development phase.)

R_e = Engineering rate per hour including overhead.

T_{ef} = Time to accomplish search using engineers files, library, DODJSS, etc. ; include travel time. A typical average is 1.25 hours per search.

R_s = Success rate in finding data in Standards Manuals and similar standardization documents.

T_{sm} = Time to accomplish search in Standards Manuals; include travel time.

C_{os} = Annual cost to develop, publish and maintain standardization documents.

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5.4.2 Example

A survey of an organization of 3000 design engineers reveals an average of four searches per week for data on parts and materials. Reviews of preferred parts lists for new designs and spot checks with engineers on various design projects indicates that 60 percent of the required data for parts and materials were found in the standards manuals or project preferred parts lists after a search averaging six minutes. A staff of ten provides standardization services including project preferred parts lists at an annual cost of $ 200,000 including overhead. The salary rate for design engineers in this organization averages $10 per hour including overhead.

$$S_{y}s = 600,000 \times \$10 (1.25 \times .60 - .10) - \$200,000$$

$$= 5s3, 900,000 - \$200,000$$

$$= \$3,700,.000$$

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5.5 Standardization Savings from Using a Stocked Standard Part in lieu of Establishing a New Standard. NAS1524-5

5.5.1 The savings attainable through the use of a stocked standard part rather than preparing a new standard may be estimated by applying the formula:

cost Savings	=	Savings from Quantity Purchases of Existing Stds.	+	cost of Establishing New Std.	+
s	=	$Q\ (C_1 - C2)$	+	Ces	+

Additional Inventory Carrying Costs	+	Additional Tangible and Intangible Savings
$I\left[\frac{Q}{2}(C_1 - C_2)\right]$	+	Y

$$Sd = Q(C1 - C2) + \frac{I}{2}(C1 - C2) + Y$$

where:

s = Savings during first year.

Sd = Savings during subsequent years.

Q = Annual numerical volume. When calculating impact on inventory this quantity is divided by 2 to reflect that the inventory is not maintained at the maximum level throughout the year.

c1 = Unit cost of the new standard part based on the projected annual. usage.

C2 = Unit cost of the standard part based on the increased quantities that would be purchased each year if it was used.

Ces = Cost of establishing and releasing a *new* standard part, including all paperwork. ($746 per item is the aerospace industry average.)

I = Inventory carrying cost in decimals. (Aerospace industry average in 1966 was .18.)

- Y = Additional cost reduction, tangible or intangible, if applicable. See Appendix 20.

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5.5.2 Example

Yearly requirements for an aerospace program require 1,000 *warning* A standard part could be used at a cost of $3.35 per unit; however, it is not stocked in the plant's inventory. A similar unit already in use as a standard part would cost $3.50 apiece in the quantities required for this particular program and other applications during the year.

S = 1000 ($3.35 - $3.50)+ $746 + .18 1000 ($3.35 - $3.50) + Y
[7 1

$$= 1000\ (-\$.15) + \$746 + .18 \left[\frac{1000}{2}\ (-\$.15)\right] + Y$$

= .$150 + $746-$13.50 + Y

= $582.50 + Y

During the fir st year the cost avoidance re suiting from elimination of qualification tests, new inspection plans, etc. , could be included.

Sd = -$150 + (- $13.50) + Y

= -$163.50+ Y

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5.6 Standardization Savings from Using a Stocked Standard Part in lieu of a New Design. NAS1524.6

5.6.1 Standardization savings that may be achieved by using a stocked standard part, rather than a new part which requires engineering and design, may be estimated by applying the formula:

cost Savings = Savings due to Quantity Purchases of Existing Standard + cost of Releasing & Stocking a New Part + cost of Qualification Testing +

$$S = Q\,(C_1 - C_2) + C_{rs} + C_{qt} +$$

Additional Inventory Carrying costs + cost to Engineer New Part + Cost for Drafting New Part + Additional Tangible and Intangible Savings

$$I\left[\frac{Q}{2}(C_1 - C_2)\right] + H_e R_e + H_d R_d + Y$$

$$S_d = Q\,(C_1 - C_2) + I\left|\frac{Q}{2}(C_1 - C_2)\right| + Y$$

3

where:

S = Savings during fir st year.

Sd = Savings during subsequent years.

Q = Annual numerical volume. When calculating the impact on inventory this quantity is divided by 2 to reflect that the inventory is not maintained at the maximum level throughout the year.

c1 = Unit cost of the new part based on the projected annual usage.

C2 = Unit cost of the standard part based on the increased quantities that would be purchased each year if it were used.

C_{rs} = Cost of releasing and stocking a new part, including all paperwork. A typical average cost is $200.

C_{qt} = Cost of qualification testing. Typical costs for various classes of parts are:

Military Standard Type -	$ 3,750
Military Standard Type to severe environments -	$ 5, 000
High Reliability Type -	$12,500

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5.6.1 (Continued)

I = Inventory carrying cost in decimals. (Averages 18 percent.)

H_e = Estimated number of hours required to engineer the proposed new part.

H_d = Estimated number of hours required to design and draft the proposed new part.

R_e and R_d = Engineering rate and Design rate per hour, including overhead. (Industry averages approximately $10 and $7.50 per hour respectively.)

Y = Additional cost reduction tangible or intangible, if applicable. See Appendix 20.

5.6.2 Example

For esthetic reasons a division wishes to design a new latching handle for electronic panels. Before initiating the project they want to establish the price of the enhanced appearance. The standard part costs $4.50 and it is estimated that the new design would not cost more than $4.75. Forty engineering hours and sixty design hours will be required. A vendor estimates tooling costs will be at least $8000. Twelve thousand handles are required during the next twelve months. Qualification to standard military environments is required.

$$S = 12,000 (\$4.75 - \$4.50) + \$200 + \$3750 +$$

$$.18 \left[\frac{12,000}{2} (\$.25)\right] + \$10 (40) + \$7.50 (60) + \$8,000$$

$$= \$3000 + \$200 + \$3750 + \$270 + \$400 + \$450 + \$8,000$$

= $16,070 of cost could be avoided during the first year by continuing to use the standard part.

If the same quantities were used during subsequent years, cost avoidance would total at least

$$S_d = \$3000 + \$270 + Y$$

$$= \$3270 + Y$$

Other cost factors might include the replacement of dies and punches now used with the standard handle; revising existing process plans and increasing the number of types of spares carried in the field.

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5.7 Standarization Savings from Control and Reduction of the Number of Items in Inventory through Simplification or Use of a Supersedure Procedure whereby inventorieds of interchangeable items are consolidated (simplified). NAS1524-7

5.7.1 The savings resulting from inventory consolidation through simplification or supersedure may be estimated by applying the formula:

$$\text{Cost Savings} = \left(\text{Cost of maintaining a part in inventory} \times \text{Number of parts super sealed}\right) - \text{cost of implementation}$$

$$S = \left(C_{mi} \times N\right) - C_{imp} \times N$$

or

$$\left(C_{mi} - C_{imp}\right) N$$

where:

S = Savings during year

C_{mi} = Yearly cost of stocking and dispersing a part. Total cost of maintaining all items in inventory divided by the number of items in inventory.

N = Number of supersedure resulting in stock consolidation.

C_{imp} = Cost of implementation per item.

NOTE: A supersedure procedure is a system whereby a new part that is interchangeable with the old part it is super sealing is stocked in the same bin as the old part. These parts are used interchangeably, but no old parts are purchased. Therefore, the old parts are "used up" by attrition.

5.7.2 Example

By using a supersedure procedure it was possible to eliminate the need for maintaining stocks of 400 additional parts in inventory. (The total number of pieces of each part or the dollar value does not affect the savings.) The average cost of maintaining an item in inventory was determined to be $200.00.The cost of implementation was determined to be $2.15 per item. (1)

$S = (C_{mi} - C_{imp})\ N$

$S = (200 - 2.15)\ (400)$

$S = \$79,140.$

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5.8 Standardization Savings from Using a Stocked Standard Part in lieu of a Nonstocked Part (simplified). NAS1524-8

5.8.1 Standardization savings that may be achieved by using stocked standard parts rather than using nonstocked, nonstandard parts may be estimated by applying the following formula:

$$\text{Cost Savings} = \left(\begin{array}{l}\text{Cost of establishing}\\ \text{and maintaining a}\\ \text{new item in}\\ \text{inventory (Average)}\end{array} - \begin{array}{l}\text{Cost of}\\ \text{implemen-}\\ \text{tation}\\ \text{(Average)}\end{array} \right) \times \begin{array}{l}\text{Number of}\\ \text{standards used}\end{array}$$

$$S = (C_{es} - C_{imp})\ N$$

where:

S = Savings during first year

S_d = Savings during subsequent years

C_{es} = The average cost of establishing a new item and maintaining it in inventory for one year, including all paperwork. ($746 per item is the aerospace industry average.)

C_{imp} = The average cost of investigating and implementing each standardization action.

C_{mi} = Yearly cost of stocking and dispersing a part. Total cost of maintaining all items in inventory divided by the number of items in inventory.

N = Number of standardization actions resulting in use of the existing standards.

5.8.2 By establishing a standardization control it was possible to convert 100 requests for use of nonstandard parts to standard parts. The average cost of investigating each item was determined to be $50.

$$S = (C_{es} - C_{imp})\ N$$

$$S = (746 - 50)\ 100$$

S = $69,600 during the first year

$$S_d = C_{mi}\ N$$

$$S_d = 200 \times 100$$

S_d = $20,000 during each subsequent year of the application.

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5.9 Standardization Savings from Using a Design Standard in lieu of detailing the data completely on each drawing. NAS 1524-9

5.9.1 Standardization Savings that may be accrued from using a design standard can be estimated by applying the formula:

$$\text{Cost Savings} = \text{Drafting Costs}\left[\begin{array}{l}\text{Number}\\\text{of pro-}\\\text{bable}\\\text{appli-}\\\text{cations}\end{array}\left(\begin{array}{l}\text{Est. hrs. to}\\\text{detail the}\\\text{design}\\\text{element}\\\text{on a}\\\text{drawing}\end{array} - \begin{array}{l}\text{Est. hrs. to}\\\text{specify a}\\\text{design}\\\text{standard}\\\text{on a}\\\text{drawing}\end{array}\right) - \begin{array}{l}\text{Est. hrs.}\\\text{to draft}\\\text{a design}\\\text{standard}\end{array}\right] + \begin{array}{l}\text{Additional}\\\text{tangible or}\\\text{intangible}\\\text{savings}\end{array}$$

$$S = R_d \left[N \cdot \left(H_{d1} - H_{d2} \right) - H_{es} \right] + Y$$

where:

S = Potential savings accrued from using the design standard.

N = Number of potential applications on engineering drawings.

H_{d1} = Estimated number of hours required to detail the design element on an engineering drawing.

H_{d2} = Estimated number of hours required to specify a design standard on an engineering drawing.

R_d = Estimated design rate per hour including overhead. (Industry average is approximately $7.50 per hour.)

H_{es} = Additional savings if applicable.

Y = Additional tangible or intangible savings if applicable.

5.9.2 Example:

One program uses 150 connectors employing a hole mounting pattern. What is the estimated cost savings accrued by using a design standard in lieu of detailing the design element each time the hole pattern is required? To delineate the above hole pattern in proper detail takes about 15 minutes. To specify the design standard takes about 2 minutes. Gathering the data, drawing and releasing the design standard takes an estimated 5 hours (300 minutes). Drafting costs are estimated at $7.50 per hour (0.125 cents per minute).

$$S = .125 \left[150\ (15-2) - 300\right] + Y$$

$$S = .125 \times 1650 + Y$$

$$S = \$206.25 + Y$$

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APPENDIX 10

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APPENDIx 20

Tangible and Intangible Factors to be considered in identifying and calculating standardization savings.

20.1 ENGINEERING

1. REDUCE TECHNICAL TIME IN PROCESSING PRODUCT DESIGN.
2. REUSE OF KNOWN ITEMS IMPROVES RELIABILITY AND REDUCES "DEBUGGING" .
3. REDUCE HAZARD OF TECHNICAL ERROR IN JUDGMENT.
4. INCREASE TIME AVAILABLE FOR WORK REQUIRING SPECIAL DESIGN OR HANDLING.
5. REDUCE NEED FOR SPECIAL COMMUNICATION BETWEEN ENGINEERS, DRAFTSMEN, PRODUCTION, ETC.
6. REDUCE "'BREAK-IN" TIME FOR NEW TECHNICAL PERSONNEL.
7. REDUCE NEED FOR MINOR SUPERVISORY DECISIONS .
8. REDUCE NEED FOR WAIVERS AND NONSTANDARD PART TESTING AND APPROVAL.
9. REDUCE REDESIGN AND REDRAFTING EFFORT.
10. IMPROVE INTERCHANGEABILITY OF PARTS, DESIGNS, PACKAGES, TEST FIXTURES, ETC.
11. PROMOTE USE OF IMPROVED METHODS AND PRODUCTS.
12. HELP ELIMINATE UNSOUND PRACTICES BASED ON PREJUDICE, TRADITION, ADVERTISING, ETC.
13. DEVELOP COST ESTIMATES MORE ECONOMICALLY.

20.2 PROCUREMENT

1. INCREASE PURCHASEING POWER THROUGH PROCUREMENT OF LARGER QUANTITIES OF FEWER ITEMS.
2. REDUCE NUMBER OF PURCHASE ORDERS, RECEIPTS, PAYMENTS .
3. **REDUCE LEAD TIME .**
4. **PROVIDE A COMMON LANGUAGE BETWEEN BUYER AND SELLER REDUCING TIME REQUIRED FOR NEGOTIATIONS .**

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APPENDIX 20 (Cont'd)

5. PUT ALL SUPPLIERS ON A FAIR COMPETITIVE BASIS.

6. PROMOTE PURCHASE BY INTRINSIC VALUE RATHER THAN BY SAILES-TALK.

20.3 QUALITY CONTROL

1. IMPROVE QUALITY CONTROL BASED ON ACCEPTED AND EXPLICIT SPECIFICATIONS.

2. DECREASE HAZARD OF MISUNDERSTANDINGS WITH SUPPLIERS

3. PROVIDE BETTER CONTROL OF END PRODUCT .

4. REDUCE AND SIMPLIFY INSPECTION (SAMPLING PLANS, ETC.)

20.4 INVENTORIES

1. REDUCE CAPITAL REQUIREMENT AND AMOUNT TIED-UP.

2. REDUCE RECORD KEEPING.

3. REDUCE STORAGE AREA.

4. REDUCE MATERIAL HAND LING .

5. REDUCE OBSOLESCENCE AND SPOILAGE HAZARDS.

6. REDUCE STOCKKEEPER'S TIME.

7. REDUCE STOCKKEEPER TRAINING REQUIRED.

8. PROVIDE BASIS FOR DATA MECHANIZATION, HAND LING, REDUCTION IN ERRORS. .

9. MORE ACCURATE AND PREDICTTABLE PLANNING AND BUDGETING .

10. PROVIDE QUICKER SERVICE .

20.5 PRODUCTION

1. MORE ROUTINE ACTIVITY AND FAMILIARITY IN FABRICATION AND ASSEMBLY.

2. DECREASE REWORK.

3. IMPROVE MECHANIZATION .

4. DERIVE ECONOMIES THROUGH SPECIAL PURPOSE MACHINES PERFORMING STANDARD OPERATIONS, UTILIZING STANDARD PARTS .

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APPENDIX 20 (Cont'd)

5. REDUCE THE NEED FOR SPECIAL TOOLING, TRAINING, LAYOUT AND TEST .

6. REDUCE PRODUCTION METHODS AND INDUSTRIAL ENGINEERING EFFORT AND MANPOWER.

7. AVOID PRODUCTION DE LAYS THROUGH STOCKED STANDARD PARTS .

20.6 MAINTENANCE

1. REDUCE BREAKDOWNS AND DOWNTIME . "

2. REDUCE PREVENTIVE MAINTENANCE TIME .

3. REDUCE REPAIR TIME .

4. DECREASE CRITICAL EXPEDITING.

5. REDUCE THE NUMBER OF UNFAMILIAR JOBS ENCOUNTERED .

6. DECREASE NUMBER OF SERVICE-SPARES .

7. DECREASE SIZE AND COMPLEXITY OF SERVICE MANUALS .

8. REDUCE OPERATOR TRAINING TIME .

20.7 GENERAL

1. MORE ROUTINE WORK FREES HIGHER SKILLED PEOPLE FOR UNIQUE ASPECTS OF PROJECT.

2. IMPROVE GENERAL COMMUNICATION .

3. EASE OF SELLING DESIGN COMPOSED OF CUSTOMER APPROVED OR RECOGNIZED DEVICES.

4. IMPROVE USER AND CUSTOMER CONFIDENCE .

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APPENDIX B: SOURCES FOR ORDERING STANDARDS

ORGANIZATION	INFORMATION PROVIDED
American National Standards Institute 11 West 42nd. Street, 13th. Floor New York, NY 10036, USA Foreign/International (212) 642-4995 Domestic: (212) 642-4900 Telex: 42 42 96 ANSI UI FAX: (212) 302-1286 (212) 398-0023	ANSI and ANSI approved industry standards. International and Foreign Standards Select draft CEN/CENELEC Standards, draft 1SO Standards
Global Engineering Documents 2805 McGaw Avenue, P. O. Box 19539 Irvine, CA 92714 USA Telephone: (800) 854-7179 (714) 261-1455 FAX: (714) 261-7892 Washington, DC USA (202) 429-7892	Industry Standards Federal Standards and Specifications Military Standards and Specifications International and Foreign Standards
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General Services Administration (GSA) Specifications Branch Seventh and D Streets, S. W. Washington, DC 20407, USA Telephone: (202) 708-9205 FAX: (202) 708-9862	Federal Standards and ., Specifications Military Standards and Specifications
Morgan Technical Library National Fire Protection Association Batterymarch Park. Room 251 Quincy, MA 02269 Telephone: (617) 770-3000, Extension 445	NEMA, NFPA, UL.
ASTM Information Center American Society for Testing Materials 1916 Race Street Philadelphia, PA 19103 Telephone: (215) 299-5474 or 5585	All ASTM Standards All 1S0 Standards

Document Engineering Company, Inc. 15210 Stagg Street van Nuys, CA 91405 Telephone: (213) 873-5566	Mil Standards and Mil Specs, ASTM, SAE, AWS, IEEE, and others.
Information Handling Services 15 Iverness Way East Englewood, CO 80150 Telephone: (303) 790-0600 (800) 525-7052	On-line data base of more than 210,000 Standards. Copies on Microfilm only.
National Institute of Standards and Technology Room A629, Administration Building National Bureau of Standards Gaithersburg, MD 20899 Telephone: (310) 975-4040	ANSI, ASME, ASTM, API NEMA, NFPA, including historical files from 1970. Computer assisted index of standards by title.
National Shipbuilding Research Program The University of Michigan Transportation Research Institute 2901 Baxter Road Ann Arbor, Michigan 48109	All NSRP reports from 1973 to present. Also has computerized list of marine industry standards.
Standards Engineering Society 11 West Monument Avenue, Suite 510 P. O. BOX 2307 Dayton, Ohio 45401 Telephone: (513) 223-2410	Guidelines for format and content of internal standards.